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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 11519, 12348, and 12389.

11413 (BARC-433) IN-LINE ANALYSIS OF FUEL REPROCESSING STREAMS: A REVIEW. Bhargava, V. K.; Chandrasekharan, E. S.; Iyer, R. H.; Rao, V. K.; Ramaniah, M. V. (Bhabha Atomic Research Centre, Bombay (India)). 1969. 20p. Dep. CFSTI (U. S. Sales Only).

Unclassified literature from January 1956 to December 1968 on in-line analysis of uranium, plutonium, and fission products in fuel reprocessing streams was reviewed. In-line analytical techniques are valuable in the early detection of any possible process malfunctions. They also help decrease the possibility of radiation exposure to analytical personnel and reduce the cost of operation. Colorimetric, radiometric, and electrochemical techniques were used for in-line work. Colorimetric methods are particularly suited for plutonium and uranium estimations over a wide range of concentrations. The simplicity of the principle of contact alpha monitoring as well as neutron monitoring makes them attractive for plutonium assaying. Similarly, total gamma monitoring aided by Ge(Li) detectors and computers offers the most effective way of tracking down fission products. Gamma absorptiometry can be used in the analyses. In electrochemical techniques, interferences from other reducible and conducting ions can be a major problem. X-ray fluorescence methods can be used for estimating a number of elements simultaneously, but the technique has not been widely exploited for in-line work. An additional list of 42 useful references relating to in-line work is also included. (auth)

11414 COMPLEXOMETRIC TITRATION OF CERIUM(III) IN A MIXTURE WITH ALUMINUM, COPPER(II), OR IRON(III) WITH alpha-(p-CRESOLAZO)-N-METHYLANABASINE ([3-(1-METHYL-2-PIPERIDYL)-2-PYRIDYLAZO]-(p-CRESOL) AS INDICATOR. Talipov, Sh. T.; Krukovskaya, E. L.; Nuritdinova, M. Tr. Tashkent. Gos. Univ.; No. 323, 89-95(1968). (In Russian).

The Ce^{3+} are titrated with EDTA solution at pH 6.5 to 7.5 (hexamine buffer solution) in the presence of the named indicator (I); at the end-point there is a sharp color change from pink-violet to yellow. The titration of Cu^{2+} with EDTA solution with I as indicator at pH 4.0 (acetate or phthalate buffer solution) is also described. When Ce^{3+} and Cu^{2+} are both present, Ce is determined in an aliquot after masking Cu with thiourea, and total Ce plus Cu is determined in another aliquot. A method was developed for the indirect complexometric titration of Al. If Ce^{3+} and Al are both present, the Ce is first titrated after masking Al with sulphosalicylic acid; an excess of EDTA solution is added to another portion of test solution, and the unconsumed EDTA is titrated with $ZnCl_2$ solution with I as indicator. With mixtures of Ce^{3+} and Fe^{3+}, the Fe is first titrated at pH 1 in the presence of pH salicylic acid as indicator, then hexamine is added to produce pH 6.5 to 7.5, and Ce is titrated with I as indicator. The error of the determination is 1 to 2% for Ce, Al, and Cu, and 2 to 5% for Fe. (Referativnyi Zh.)

11415 RAPID DETERMINATION OF VANADIUM AND MOLYBDENUM IN CATALYSTS. Bagbanly, I. L.; Ali-Zade, T. D.; Radzhabova, F. M. Uch. Zap. Azerb. Gos. Univ., Ser. Khim. Nauk; No. 1, 30-2(1968). (In Russian).

The sample to be analyzed for Mo and V was fused in a Pt crucible with Na_2CO_3. The melt was dissolved in 1:2 HCl, the SiO_2 was filtered off, and the filtrate diluted to a volume of 250 ml. Thiourea (to mask Cr), catechol solution, aniline, and $CHCl_3$ were all added to an aliquot, and the mixture was shaken for 1 min. The extinction of the extract was measured using a red filter against $CHCl_3$. There was no interference from 1500-, 700-, 600-, or 50-fold amounts of Si, Al, Cr, or Mo, respectively, nor from W, P, Co, Ni, Bi, Hg, Mn, or Te. The calibration graph is rectilinear for 1 to 220 μg of V in 7 ml of extract. The Mo is determined absorptiometrically as the thiocyanate complex. (Referativnyi Zh.)

11416 EXTRACTION-PHOTOMETRIC DETERMINATION OF SAMARIUM AND STUDY OF THE STRUCTURE OF ITS COMPLEX WITH ALIZARIN RED S AND PHENAZONE BY INFRARED SPECTROSCOPY. Akhmedli, M. K.; Melikov, A. A. Uch. Zap. Azerb. Gos. Univ., Ser. Khim. Nauk; No. 1, 18-23 (1968). (In Russian).

At pH 5 the 1:3:1 complex formed by Sm, Alizarin red S, and phenazone is extracted into isobutyl alcohol; the extinction of the extract is measured at 536 nm. Interference by many cations, anions, and masking agents is studied. In the presence of hydrazine, 20-fold amounts of Sr or Ca do not interfere. The method is applied to the analysis of Sm-Ga-Te and Sm-Se alloys. (Referativnyi Zh.)

11417 USE OF ANIONITES IN THE ANALYTICAL CHEMISTRY OF MOLYBDENUM. Eristavi, D. I.; Brouchek, F. I.; Macharashvili, T. G. Tr. Gruz. Politekh. Inst.; 3: No. 123, 53-60(1968). (In Russian).

Anionite AV-17 (F^- form) binds Mo so strongly that it is not desorbed from a 13-ml column by the passage of 1 liter of 2% NaF solution or 1.5 liters of 1% NaF solution. Anionite AV-16 (F^- form) retains Mo less strongly, and anionite AN-2Fg (F^- form) even less strongly. To separate Mo from elements that form less stable F^- complexes, AV-16 and AV-17 are the most sutiable anonites, with 1% or 2% NaF solution as eluent. The optimum rate of elution is 5 ml per min; at higher rates the coefficient of desorption of Mo is markedly increased. (Referativnyi Zh.)

11418 DETERMINATION OF SELENIUM AND TELLURIUM IN SULPHIDE ORE BY USING ION-EXCHANGE CHROMATOGRAPHY. Stephin, V. V.; Ponosov, V. I.; Novikova, E. V.; Stashkova, N. V.; Sushkova, S. G.; Murashova, V. I.; Emasheva, G. N. Tr. Vses. Nauch.-Issled. Inst. Stand. Obraztov Spektral. Etalnov; 3: 109-24(1967). (In Russian).

A 0.5-g sample of sulfide ore was dissolved in HNO_3, the solution evaporated, and the residue dissolved in 0.3N HCl. The solution was applied to a column of KU-2 cation resin, and the Se and Te was eluted with HNO_3. The eluate was evaporated; urea was added; and the solution was boiled and diluted to 50 to 100 ml with 0.1N HCl. To an aliquot of the solution was added 1% diantipyrinylmethane (I) in 50% acetic acid, and the resulting Te complex was extracted with dichloroethane (II). The Te complex was reextracted into H_2O, HBr and ascorbic acid were added, the solution was shaken, and the organic layer was filtered through a dry filter. The extinction of the organic layer was measured at 453 nm to determine Te. To separate Se from Te, an aliquot of the eluate from the cation exchange (containing 90 to 400 μg of Se plus Te) was evaporated almost to dryness, 4N HCl was added, and the solution was passed through a column of anionite AV-17 (Cl^- form). The Se was eluted with 4N HCl and then the Te with 1N HCl. Each eluate was evaporated to 15 to 20 ml; 1 ml of 10% $SnCl_2$ solution in HCl was added to each; the solution was diluted to 50 ml; and the extinction of the solutions were measured at

453 nm. For the polarographic determination of Se and Te, the HNO_3 eluate was evaporated with H_2SO_4, the residue was diluted to 50 ml and divided into halves. For the determination of Se (E_k at 0.55V), 100 μg of Te were added, the solution was diluted to 50 ml, and the polarogram was recorded. To the solution for the determination of Te (E_k at 0.9V) 10 μg of Se was added, the solution was diluted to 50 ml, and the polarogram was recorded. (Referativnyi Zh.)

Chemical and Spectral Procedures

Refer also to abstracts 11549, 11649, and 12427.

11419 (AWRE-O-51/69) COMPARISON OF THE NETWORK METHOD OF PULSE-HEIGHT ANALYSIS WITH CRYSTAL SPECTROMETRY FOR LIGHT ELEMENT MICROANALYSIS. Ranzetta, G. V. T.; Scott, V. D. (Atomic Weapons Research Establishment, Aldermaston (England)). Nov 1969. 17p. Dep. CFSTI (U. S. Sales Only). UK 4s.

A comparison was made of pulse-height and crystal spectrometry methods for the microdetermination of light elements, such as B, C, N, O, and F with reference to qualitative and quantitative microanalysis. A few practical illustrations in metallurgy—inclusion identification and oxygen penetration into corroded metals—have been included for the qualitative evaluation. Quantitative aspects are discussed in terms of measurements on a series of carbides, chosen because of their good conducting property and the ready availability of a pure standard. The data indicate that the two methods do not always give identical results, and it is suggested that the network method of pulse-height analysis has potential errors that arise from the basic assumption that the shape of the x-ray emission spectrum from a particular element differs only in intensity according to the amount of element present. Additional complications, such as the overlapping of the light element spectrum with soft x-ray lines from the heavier elements are also discussed. (P.C.H.)

11420 (BARC-416) THE PHASE EQUILIBRIUM COMPOSITION OF U_3O_8 AND THE O/U ANALYSIS OF THE URANIA SAMPLE. Chandrasekharaiah, M. S.; Dharwadkar, S. R. (Bhabha Atomic Research Centre, Bombay (India)). 1969. 17p. Dep. CFSTI (U. S. Sales Only).

Studies were made on the determination of the O/U ratio in UO_2 by oxidation in air and then by determination of the composition from the increase in weight. An attempt was made to establish the necessary experimental conditions required to obtain an accuracy of ±0.002 in O/U analysis by this method. Studies were also made on the phase equilibrium composition of U_3O_8, which is produced by the oxidation of UO_2. The results showed that the U_3O_8 phase formed is far from stoichiometric, and the oxygen deficiency in the U_3O_8 phase formed at temperatures above 500°C is not removed completely on cooling to room temperature. It was concluded that the ignition method for the O/U determination in UO_2 samples is experimentally simple and would yield good precision provided care is taken to eliminate the moisture pick-up by U_3O_8. However, the accuracy would depend on the temperature of oxidation selected. Data are tabulated. (P.C.H.)

11421 (BARC-422) CHEMICAL METHODS OF ANALYSIS OF PLUTONIUM: A LITERATURE SURVEY. Natarajan, P. R. (Bhabha Atomic Research Centre, Bombay (India)). 1969. 13p. Dep. CFSTI (U. S. Sales Only).

A review of methods of analysis of plutonium is presented. The chemical methods are divided broadly into spectrophotometric and redox methods. (53 references). (D.H.M.)

11422 (BARC-441) SPECTROCHEMICAL DETERMINATION OF SOME RARE EARTHS IN URANIUM USING LITHIUM FLUORIDE-SILVER CHLORIDE CARRIER. Joshi, B. D.; Patel, B. M. (Bhabha Atomic Research Centre, Bombay (India)). 1969. 20p. Dep. CFSTI (U. S. Sales Only).

An emission spectrographic method for the determination of certain rare earths (Ce, Sm, Eu, Gd, Dy, Ho, Er, and Lu) at submicrogram levels in uranium samples was developed. A mixture of lithium fluoride–silver chloride and graphite powder in the proportion 1:1:2 is used as carrier–buffer. The rare earths are separated from uranium using cellulose column and ether–nitric acid mixture and finally precipitated with lanthanum carrier. The separated rare earth impurities are dissolved in 200 microlitres of HCl. Twenty microlitres of this solution are loaded on graphite electrode containing the carrier–buffer. The samples are excited in a dc arc carrying 13 amperes. Thulium is used as an internal standard. The detection limits in ppM on the basis of 5 g uranium sample are: Eu, Gd, Er ... 0.02; Dy ... 0.05; Sm, Ho, Lu ... 0.2; and Ce ... 0.5 ppM. The standard deviation by this procedure ranges from 8 to 17% for different elements. (auth)

11423 (CEA-N-1148, pp 3-80) CHEMICAL ANALYSES. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Developments are reported for studies on: chemical analysis of Pu, chemical and electrochemical analysis in solution; preparation of irradiated or reconstituted fuel solutions (U and Pu) for analysis purposes; physicochemical analysis of Pu and isotopic analysis; high resolution, optical emission, atomic absorption, and x-ray fluorescence spectrometry; gas analysis; chemical analysis in solution; control of nuclear materials; analyses of nuclear fuels; and analyses in the laboratory of the Cadarache Nuclear Center. (P.C.H.)

11424 (CEA-R-3457(2)) ISOTOPIC ANALYSIS OF ^{235}U BY EMISSION SPECTROMETRY. II. DETERMINATION OF THE $^{235}U/^{238}U$ RATIO USING A SPECTROGRAPH AND ELECTRODELESS LAMPS. Capitini, Robert; Ceccaldi, Maurice; Leicknam, Jean-Pierre; Rabec, Jacques (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Feb 1970. 50p. (In French). Dep. CFSTI (U. S. Sales Only).

Emission spectroscopy, which has no memory effect, can constitute a complementary method for isotopic analysis when a high accuracy is not required. It is possible to apply this method in laboratories equipped with all the usual spectrochemical analysis equipment. An acceptable accuracy can be obtained by using a photographic plate spectrograph that has not undergone any modification; the isotopic lines used are located at 4,244 Å. By carrying out corrections necessitated by the very rich nature of the uranium spectrum, isotopic analysis can be effected with a relative accuracy of about 2.5 to 3.0% in the neighborhood of the natural abundance; this accuracy can reach and exceed 1% for samples enriched in the 235 isotope. These results, for routine determinations, are close to those which can be obtained with grating or interferometric equipment. (auth) (France)

11425 (CEA-R-3870) APPLICATION OF ATOMIC ABSORPTION SPECTROPHOTOMETRY TO THE RAPID ANALYSIS OF SOME ELEMENTS IN URANIUM. Buffereau, Michel; Robichet, Jacques (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Dec 1969. 39p. (In French). Dep. CFSTI (U. S. Sales Only).

After a brief review of the main conditions for analysis for impurities in uranium, characteristics of the sample solution and analytical conditions in presence of uranium were studied. Some interferences are shown and comparative results are given. Limits of application of the method are discussed. (auth)

11426 (CEA-R-3883) DETERMINATION OF CORRECTION COEFFICIENTS FOR QUANTITATIVE ANALYSIS BY MASS SPECTROMETRY. APPLICATION TO ANALYSIS OF IMPURITIES IN URANIUM. Billon, Jean-Pierre (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Jan 1970. 59p. (In French). Dep. CFSTI (U. S. Sales Only).

After a brief review of the basic principles used in the spark source mass spectrometry it is shown that the method can be applied to quantitative analysis when attention is paid to theoretical problems. A constant relation in time between the analyzed solid sample and the ionic beam produced is assumed and experimental relative sensitivity factors for impurities in uranium matrix are determined. Results are in good agreement with an unelaborate theory on the ionization yield in the spark source and the use of the theoretical sensitivity factors in uranium matrix is developed. (auth) (France)

11427 (CEA-R-3909) CHEMICAL ANALYSIS OF RADIOACTIVE LIQUID WASTES. VOLUMETRIC DETERMINATION OF SULFATES IN THE PRESENCE OF PHOSPHATES, "NITROCHROMAZO" BEING USED AS AN INDICATOR. Testemale, Gilbert; Girault, Jacques (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Dec 1969. 20p. (In French). Dep. CFSTI (U.S. Sales Only).

A simple titration technique of SO_4^{2-} ions in the presence of PO_4^{3-} ions was perfected. The pH of the medium is stated to be 1.7 to 2.0 and the color of the indicator changes from violet to blue. The method is quick, accurate and can be fitted to biological studies or in the fertilizer industry. The synthesis of nitrochromazo (4,5-dihydroxy-3,6-bis[(4-nitro-2-sulfophenyl)azo]-2,7-naphthalenedisulfonic acid is described. (auth)

11428 (JAERI-4050) ANALYSIS OF ZIRCONIUM AND ITS ALLOYS. (Japan Atomic Energy Research Inst., Tokai). Jul 1969. 212p. (In Japanese). Dep. CFSTI (U. S. Sales Only).

Analytical methods are described for determining Al, B, C, Ca, Cd, Cl, Co, Cr, Cu, Fe, H, Hf, Li, Mg, Mn, Mo, N, Nb, Ni, O, Pb, Si, Sn, Ti, U, and W in zirconium and Zircaloy, and for determining Nb and Ta in zirconium alloys. Most of the methods were presented or tested in the Committee on Analytical Chemistry of

Nuclear Fuels and Reactor Materials, JAERI. An important subject of the committee was the preparation of standard samples. The preparation and homogeneity tests of the zircaloy samples (JAERI-Z4, -Z5, -Z6, -Z7) are recorded. Comparison data of the analytical results among 14 participating laboratories in the committee are also presented. (auth) (NSA of Japan)

11429 (RFP-1391) SPECTROPHOTOMETRIC DETERMINATION OF PLUTONIUM III, IV, AND VI IN NITRIC ACID SOLUTIONS. Hagan, Paul G.; Miner, Frend J. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 24 Nov 1969. Contract AT(29-1)-1106. 10p. Dep. CFSTI.

A method is reported for the quantitative spectrophotometric determination of plutonium (III), (IV), and (VI) existing separately or in mixed oxidation states in nitric acid. The nitric acid concentration varied from 1 to 4 molar for Pu(III), and 1 to 10 molar for Pu(IV) and (VI). Molar absorptivity values are given for the major absorption peaks with an evaluation of their spectral reproducibility. With these absorptivity data and the mathematical approach of Ochsenfeld and Schmieder a method is presented for a calculation to determine the molar concentration of each oxidation state. (auth)

11430 HOW SENSITIVE ARE CONTENT DETERMINATIONS BY X-RAY EXCITATION USING RADIOACTIVE X-RAY SOURCES. Brunner, G. (Institut fuer Angewandte Radioaktivitaet, Leipzig). Isotopenpraxis; 5: 328-33(Sep-Oct 1969). (In German).

Absolute fluorescence and scattered radiation yields for saturation thickness and thin samples have been calculated under practical conditions taking into account a geometry factor including the horizontal dimension of the sample. The sensitivities of measurement hence calculated show that low concentrations of comparatively light or medium elements may be especially well measured, if either energies nearly above the absorption edge are used or, at comparatively high excitation energies, the scattered radiation is separated. Measurements without separating the scattered radiation are possible at comparatively high excitation energy in the case of high concentrations of such elements. For certain conditions a slight increase of sensitivity with increasing excitation energy may be noted here. In the case of heavy elements the point of view of sample thickness is often more important than the selection of excitation energy. For this sample comparatively high sensitivities are obtainable, but this may raise the question of absolute intensities in view of the detector radiation background. (auth)

11431 ON THE ASPECTS OF NON-DISPERSION X-RAY EMISSION ANALYSIS BY RADIONUCLIDE SOURCES. Dietzsch, W. (VEB RFT Messelektronik, Dresden). Isotopenpraxis; 5: 334-8(Sep-Oct 1969). (In German).

Starting from the technological situation and capacity of dispersive and nondispersive x-ray spectrometers, the dispersive and nondispersive techniques are compared. In view of some principal drawbacks of the dispersive x-ray spectrometers, possibilities of applying various types of nondispersive spectrometers are briefly described. (auth)

11432 COMPLEXIMETRIC TITRATIONS WITH TRIETHYLENETETRAMINEHEXAACETIC ACID. Harju, Leo; Ringbom, Anders (Abo Akademi, Finland). Anal. Chim. Acta; 49: 221-30(Feb 1970).

The potentialities of TTHA as a reagent for the complexiметric titration of various metals are discussed, and particular attention is paid to the conditions under which 1:1 and 2:1 complexes are formed. The conditional constants for the formation of 2:1 and 1:1 complexes are calculated and presented graphically as functions of pH for the metals Ag, Al, Ba, Sr and Ca, Cd, Co(II), Cu(II), Fe(III), Hg(II), La and some lanthanides (Nd, Er), Mg, Mn, Ni, Pb, Th, and Zn. The pM values at the two equivalence points at different pH values are also given. General comments on the constants and their use are presented. (auth)

11433 DETERMINATION OF OXALATE IONS IN IRRADIATED ALKALI METAL OXALATES. Gal, O. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Anal. Chim. Acta; 49: 370-3 (Feb 1970).

A modified copper(II)–benzidine method for the determination of oxalate ions in irradiated alkali metal oxalates is presented. In addition the copper–benzidine complexes of various inorganic anions, including some radiolytic products of oxalate salts, in the presence of alkali metal ions, are discussed; the results obtained give useful information on possible interferences in the determination of oxalate ions in irradiated samples. (D.H.M.)

11434 SPECTROCHEMICAL ANALYSIS OF ZIRCONIUM AND ITS ALLOYS. VII. SPECTROGRAPHIC DETERMINATION OF IMPURITIES IN ZIRCALOY-2 BY THE POINT-TO-PLANE HIGH VOLTAGE SPARK AND INTERRUPTED A. C. ARC TECHNIQUES. Matsumura, Tetsuo; Mizuno, Tomomi (Kobe Steel Ltd., Kobe, Japan). Jap. Anal.; 18: 1439-47(Dec 1969). (In Japanese).

A spectrographic method for the quantitative determination of aluminum, cobalt, copper, hafnium, manganese, molybdenum, silicon, titanium, vanadium, boron, cadmium, lead, and tungsten in Zircaloy-2 was developed. The point-to-plane method, in which solid disk samples were excited without any pretreatment, offered good workability and improved reproducibility compared with the oxide d-c arc technique. Precision of the method was up to about 10% of the amount present at the 10 to 500 ppM level and less than 15% below the 1 ppM level. The spectrographic and chemical results were in close agreement. (auth)

11435 RAPID DETERMINATION OF NIOBIUM, ZIRCONIUM, MANGANESE, CHROMIUM, VANADIUM, AND CALCIUM IN ILMENITE BY X-RAY FLUORESCENCE. Hisano, Kingo; Oyama, Kiyoshi (Ishihara Sangyo Co., Ltd., Kusatsu, Japan). Jap. Anal.; 18: 1508-9(Dec 1969). (In Japanese).

The rapid determination of small amounts of niobium, zirconium, manganese, chromium, vanadium, and calcium in ilmenite was investigated by the standard addition method. The concentration of these elements in ilmenite was from 0.1 to 1.0% as oxides. A sample and dispersion medium, consisting of paraffin, lead stearate, stearic acid, and polyethylene, were placed in a porcelain crucible, and melted on a heater. The obtained mixture was poured into an aluminum ring and pressed at 100 kg/cm^2. (auth)

11436 EXTRACTION-ABSORPTIOMETRIC DETERMINATION OF COPPER(II) WITH 4-(2-PYRIDYLAZO)-RESORCIN. Tomioka, Hideo; Terajima, Kuniko. Tokyo Kogyo Shikensho Hokoku; 64: 402-7(Oct 1969). (In Japanese).

An absorptiometric method for the determination of minute amounts of copper(II) by the solvent extraction of the red complex of copper with 4-(2-pyridylazo)-resorcin from pH 4 to 5 solutions was studied. The extraction of the complex into tributyl phosphate is greatly enhanced by the addition of 3 g of sodium chloride as salting-out agent. The molar extinction coefficient in tributyl phosphate at 550 mμ is 1.56×10^4, and the sensitivity according to Sandell's expression is 0.004 μg/cm^2. Beer's law is obeyed up to 4 μg/ml of copper for absorbance measured at 550 mμ. Nickel, cobalt, iron, vanadium, indium, and gallium interfere with the determination of copper by this reagent. The method was applied to the analysis of copper in lead metals, and the results were in good agreement with those obtained by the diethyldithiocarbamate method. (auth)

11437 VARIABLES IN ^{18}O ISOTOPIC ANALYSIS BY MASS SPECTROMETRY. Taylor, James W.; Chen, I-jen (Univ. of Wisconsin, Madison). Anal. Chem.; 42: 224-8(Feb 1970).

The study of oxygen isotope effects on organic reactions requires a general analysis method for ^{18}O that is reproducible to ±0.1%. With a modified combustion procedure, followed by isotope-ratio mass spectrometric determination of the ^{18}O content, it is possible to approach these reproducibility limits. A systematic investigation of the variables in the conversion and measurement and suggested techniques for minimizing memory effects in the combustion train and in the mass spectrometer is reported. (auth)

11438 RAPID SPECTROPHOTOMETRIC DETERMINATION OF URANIUM IN ORES. Florence, T. M.; Farrar, Yvonne J. (Australian Atomic Energy Commission, Lucas Heights, New South Wales). Anal. Chem.; 42: 271-3(Feb 1970).

A specific method was developed for the determination of uranium in ores by combining preliminary trioctylphosphine oxide extraction of uranium from nitric acid solutions with a previously reported spectrophotometric method for uranium using the reagent 2-(2-pyridylazo)-diethylaminophenol (PADAP). Because of the high sensitivity of the PADAP reagent small sample weights can be used, thus avoiding long dissolution times. With a 100-mg sample, the sensitivity of the method is 15 ppM of U_3O_8 in an ore. The method was applied successfully to a wide variety of ores with U_3O_8 contents ranging from 0.02 to 0.8%. (D.H.M.)

11439 AZONOL A: A NEW METALLOCHROMIC REAGENT. PHOTOMETRIC DETERMINATION OF COBALT AND SCANDIUM. Budesinsky, B.; Svecova, J. (Univ. of Waterloo, Ont.). Anal. Chim. Acta; 49: 231-40(Feb 1970).

3-Antipyrinylazo-2,4-pentanedione (azonol A) forms brick-red and wine-red complexes with Co(II), Pd(II), Ni, Fe(II), Cu(II), Zn, Cd, Hg(II), Pb(II), Mn(II), Sc, Y, lanthanons, Zr, Hf, Th and Bi, in the pH range of 1.00 to 10.00. The complexes usually have a metal:ligand ratio of 1:2, except for the thorium and bismuth complexes which are 1:3. Complexation with cobalt(II) at pH 1.10 in the presence of EDTA allows a selective determination of cobalt; of 25 cations studied, only 4-fold molar ratios of vanadium(V), 6-fold molar ratios of palladium(II), copper(II) and scandium and 8-fold

molar ratios of zinc and iron(II) caused interference in the determination of 0.5 μmole of cobalt(II). Among 15 anions, 20-fold molar ratios of oxalate and 30-fold molar ratios of cyanide caused low results. Scandium can be determined at pH 1.10 in presence of cyanide; only bismuth, thorium, hafnium and iron(III) interfere seriously. (auth)

11440 THEORETICAL AND PRACTICAL CONDITIONS FOR X-RAY FLUORESCENCE CHEMICAL QUANTITATIVE ANALYSIS. Tertian, Robert (Societe de Produits Chimiques, Pechiney-Saint-Gobain, France). Chim. Anal. (Paris); 51: 525-36(Nov 1969). (In French).

X-ray fluorescence spectrometry can stand as a general tool for quantitative chemical analysis once the major difficulty lying in the matrix effect, i.e., the physical structure and the chemical composition of the sample, has been solved. Direct examination of powders can hence provide accurate determinations only at the cost of an exacting standardization of the sample, so that the possibilities of that technique, notwithstanding the existence of important applications, are however limited. The use of homogeneous specimens, consisting of ordinary solutions or solid solutions as obtained by fusion techniques, removes those obstacles although the influence of the general chemical composition, also called "interelement effect," must be considered. The dilution technique, using a double measurement, appears to be the simplest, most general, and most rigorous mathematical correction method for that effect. The principle of that method and its use for the analysis of solids and liquids are described. Experimental and application examples (rare-earths analysis) are included. (auth)

11441 FRACTIONATION EFFECTS IN THE MEASUREMENT OF MOLYBDENUM ISOTOPE ABUNDANCE RATIOS. Rees, C. E. (Univ. of California, San Diego, La Jolla). J. Mass Spectrom. Ion Phys.; 3: 71-80(Sept 1969).

During measurements of molybdenum isotope abundance ratios by solid-source mass spectrometry, isotope effects were observed which may not be explained in terms of a Rayleigh distillation from the sample filament. A model was developed in which there is imperfect mixing between the surface and subsurface layers of the sample. Such a model will be appropriate in cases where samples do not melt on mass spectrometer filaments. (auth)

11442 ELECTRON BEAM MICROANALYSIS OF IRRADIATED NUCLEAR FUELS. Kegel, B. (Kernforschungszentrum, Karlsruhe, Ger.). Kerntechnik; 11: 631-4(Nov 1969). (In German and English).

Electron beam microanalysis, after appropriate modification of the instruments, can be successfully used for the investigation of irradiated materials. The sensitivity of the analysis depends on the exposure rate emitted by the sample which, in turn, depends on the specific activity and on the size of the sample. By preparing sufficiently small samples it is possible to investigate irradiated nuclear fuels up to specific burn-ups of 100,000 MWd/t. Some examples of analyses and detection limits are given. Further development work is being actively pursued, and it may be anticipated that it will be possible to make full use of the advantages of electron beam microanalysis for investigating radioactive materials. (auth)

11443 INHIBITORY EFFECT OF THORIUM(IV) ON CATALYTIC CHEMILUMINESCENT REACTION OF LUMINOL WITH HYDROGEN PEROXIDE. Dubovenko, L. I.; Chang Tu Heu (Kiev State Univ.). Ukr. Khim. Zh.; 35: 957-61(1969). (In Russian).

The effects of thorium(IV) on the chemiluminescent reaction of luminol with hydrogen peroxide in the presence of the catalysts copper and hemin in alkaline medium were studied. It was found that thorium(IV) is the inhibitor of the reaction with the maximum inhibiting effect being observed at pH 9 to 11. The inhibiting action is caused by the formation of a compound of thorium and hydrogen peroxide in the ratio of 1:1. The effects of concentration, separation component reactions, and certain complexing agents, Complexon III, triethanolamine, and trivinylamine were studied. The optimum conditions of the reaction in the luminol–copper(II)–thorium(IV)–hydrogen peroxide system were determined and a method for the determination of microquantities of Th in solution (in the absence of extraneous ions) by a chemiluminescent photographic method was worked out. The sensitivity of the determination was 0.1 μg Th/ml with an average relative error of ±15%. (tr-auth)

11444 DETERMINATION OF TITANIUM IN HIGH-PURITY MOLYBDENUM AND TUNGSTEN METALS WITH DIANTIPYRYLMETHANE AFTER SEPARATION BY EXTRACTION OF ITS CUPFERRON COMPLEX. Donaldson, Elsie M. (Dept. of Energy, Mines, and Resources, Ottawa). Talanta; 16: 1505-12 (Dec 1969).

A method for determining 0.0005 to 0.10% of titanium in high-purity molybdenum and tungsten metals is described. After sample dissolution, titanium is separated from the matrix materials by chloroform extraction of its cupferronate from an alkaline (pH 8) tartrate–EDTA medium, then determined spectrophotometrically with diantipyrylmethane at 390 nm. Interference from manganese during extraction is eliminated with sodium sulphite. Iron, zirconium, thorium, tin, aluminium, and antimony are partially extracted under the proposed conditions, but moderate amounts of these elements may be present in the sample solution without causing error in the results. Interference from iron(III) during color development is eliminated with ascorbic acid. Other impurities in the two high-purity metals described do not interfere in the proposed method. (auth) (UK)

11445 EXTRACTION AND DETERMINATION OF MOLYBDENUM WITH TRIBUTYL PHOSPHATE APPLICATION TO ANALYSIS OF COPPER–MOLYBDENUM ORES. Caiozzi, M.; Zunino, H.; Sepulveda, L. (Univ. of Chile, Santiago). Talanta; 16: 1590-3(Dec 1969).

A differential spectrophotometric method is described for the determination of molybdenum by means of solvent extraction using tributyl phosphate of the peroxymolybdate complex formed with H_2O_2 in 3.5M H_2SO_4. The extraction parameters were studied, and the behavior of some other ions is reported. The method is used for ore analysis. (auth) (UK)

11446 SPECTROPHOTOMETRIC DETERMINATION OF RUTHENIUM WITH 8-QUINOLINOL. Hashitani, Hiroshi; Katsuyama, Kazuo; Motojima, Kenji (Japan Atomic Energy Research Inst., Ibaraki). Talanta; 16: 1553-9(Dec 1969).

A spectrophotometric method is described for the determination of 2 to 80 μg of ruthenium. The method involves oxidation of ruthenium to ruthenate, addition of 8-quinolinol, adjustment of the pH to 4 to 6.5, digestion of the complex formed at 85°C for 30 min, extraction with chloroform, and measurement of absorbance at 430 nm. Almost all other metals and excess of reagent are removed by washing the extract. About 98% of ^{106}Ru tracer was recovered. (auth) (UK)

11447 COLORIMETRIC DETERMINATION OF THORIUM WITH METHYLTHYMOL BLUE. Adam, Jiri; Pribil, Rudolf (Charles Univ., Prague. Polarographic Inst., Prague). Talanta; 16: 1596-1601(Dec 1969).

Thorium forms with Methylthymol Blue (MTB) in alkaline medium (pH 9 to 10) a complex of the composition $Th(MTB)_2$, even in the presence of EDTA, which masks almost all metals against the reagent. This can be used for selective determination of traces of thorium (0.5 to 2.8 ppM) by measurement of the absorbance at 535 nm. (auth) (UK)

11448 PINACYANOL POLYMOLYBDATE AND VOLUMETRIC DETERMINATION OF THORIUM. Babko, A. K.; Turova, D. S.; Turov, P. P. (Kiev Technical Inst.). Ukr. Khim. Zh.; 35: 953-7 (1969). (In Russian).

Pinacyanol chloride (PzCl), an intensive-blue color dye (1,1-diethyl-2,2′-quinocarbocyanine chloride) (λ_{max} = 608 mm, ε = 13.4 × 10^4) at pH of 3 to 4 in 30% alcohol–water solution forms with molybdate, as a result of solid phase reaction, a thin suspension of pinacyanol polymolybdate of pink color (λ_{max} = 520 mm, ε = 4.1 × 10^4). On the basis of photometry, centrifugations, and analysis of the compound, which was isolated in the solid state, it is possible to represent the composition as $Pz_3[H_3Mo_6O_{21}]$. Pinacyanol polymolybdate is not extracted with organic solvent. A method was worked out for the volumetric determination of thorium by using ammonium molybdate and PzCl as indicator, the sensitivity is 10 micrograms Th/ml with an error of approximately 1.5%. (tr-auth)

Radiometric Procedures

Refer also to abstracts 11643, 11646, 11738, 11770, and 12893.

11449 (GA-9608) METHODS FOR DETERMINING COATING CONTAMINATION AND ITS DISTRIBUTION IN NUCLEAR FUEL PARTICLES. Steward, K. P. (Gulf General Atomic, Inc., San Diego, Calif.). 27 Aug 1969. Contract AT(04-3)-633. 51p. (CONF-691027-1). Dep. CFSTI.

From Fall Meeting of American Ceramic Society, Seattle, Wash.

Studies were made on the level of contamination and its distribution in the BISO and TRISO fuel particles. Electron microprobe analysis was used to determine contamination profiles in highly contaminated BISO particles, and the coating removal/activation analysis and mica foil techniques were used to obtain the uranium contamination levels and distributions in TRISO particles. The electron microprobe was most useful for measuring high contamination levels down to 100 ppM, the grinding/activation analysis technique for medium contamination levels down to perhaps

0.2 ppM, and the mica foil technique down to about 0.001 ppM. The upper limit was 10 ppM for the mica foil method due to the high track density obtained at such contamination levels. Reduction of irradiation time and/or fluence could increase this by an order of magnitude or more. (V.C.W.)

11450 (RD/B/N-1499) DETERMINATION OF GADOLINIUM IN IRRADIATED GADOLINIA-MAGNESIA MIXTURES. Robins, I. H.; Hilton, D. A. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jan 1970. 8p. Dep. CFSTI (U. S. Sales Only).

Gadolinium is determined in irradiated Gd_2O_3 – MgO mixtures by titrating an acetic acid solution of these oxides with sodium oxalate. The ^{153}Gd activity in solution is used as an internal indicator and this is measured at regular intervals throughout the titration by high resolution γ spectrometry, until complete precipitation of gadolinium oxalate is obtained. The acetate ions in solution have little effect on the overall reaction and the proposed method has an accuracy and precision of the order of 0.5 per cent. (auth) (UK)

11451 RADIOCHEMICAL STUDIES ON MANGANESE NODULES OF DEEP-SEA ORIGIN. Ku, Teh-lung (Woods Hole Oceanographic Institution, Mass.); Broecker, Wallace S. Deep-Sea Res. Oceanogr. Abstr.; 16: 625-37(Dec 1969).

Manganese nodules from different parts of the ocean floor were analyzed for their uranium, thorium, protactinium, and radium contents. The uranium: thorium ratio in nodules is quite variable, and is 3 to 6 orders of magnitude lower than that in seawater. Uranium concentrations range from 4 to 13 ppM, with most values falling between 6 and 10 ppM. Thorium concentrations have a much wider spread (3 to 150 ppM) and reflect both a geographic and depth dependence. The ^{230}Th and ^{231}Pa in the outermost layers of a nodule greatly exceed the amounts which may be supported by the uranium present. The decrease with depth of these two isotopes allows the growth rates of the nodules to be determined. The rates for eighteen specimens vary from <1 to 6 mm/10^6 year; most of these fall within rather narrow limits (2 to 4 mm/10^6 year). The ^{230}Th: ^{231}Pa ratios at the nodule surface are considerably smaller than that predicted from the production of these two nuclides by the uranium dissolved in the ocean. While an activity ratio of 11 might be anticipated, values as low as 2.4 were observed. Since ^{230}Th: ^{231}Pa ratios considerably greater than 11 are found at the tops of deep-sea sediment cores, the two species must become separated during the sedimentary process. The distribution of ^{230}Th and ^{231}Pa on the surface of a given nodule is not uniform. Higher concentrations occur on the upper than on the lower sides. This suggests that these nuclides are precipitated only on those portions of the nodule in contact with seawater. Measurements of ^{226}Ra reinforce the conclusion that this element migrates in sedimentary deposits. For the oceans as a whole the amount of ^{230}Th and ^{231}Pa in manganese nodule deposits is probably no more than 5% of that generated by the uranium dissolved in the sea. (auth) (UK)

11452 ROUTINE METHOD FOR THE DETERMINATION OF TRITIUM IN RAIN AND RIVER WATERS BY ELECTROLYTIC CONCENTRATION BEFORE LIQUID SCINTILLATION COUNTING. Metson, P. (Lab. of the Government Chemist, London). Analyst; 94: 1122-9(Dec 1969).

A routine method is described for the measurement of tritium in rain and river waters by liquid scintillation counting after enrichment by electrolysis. A relatively large enrichment is achieved in a small cell by use of a continuous feed system that requires a minimum of attention. Electrolysis is carried out in a bank of standardised cells, and activities are obtained to an accuracy of better than 15 percent without the need for deuterium determinations. (auth) (UK)

11453 LIQUID-SCINTILLATION RADIOASSAY OF ^{14}C-LABELED HEMOGLOBIN IN A THIXOTROPIC GEL. Newman, Joseph W.; Lichtman, Herbert C. (State Univ. of New York, Brooklyn). J. Nucl. Med.; 10: 261-2(June 1969).

A simple method of liquid-scintillation radioassay of ^{14}C-labeled hemoglobin in a thixotropic gel is described. The optimal counting efficiency for this system is 86 to 88%. This method can be used to study hemoglobin metabolism in patients in whom hemoglobin has been labeled in vivo. (auth)

11454 FAST RADIOCHROMATOGRAPHIC DETECTION OF TRITIUM WITH LIQUID SCINTILLATORS AT LOW TEMPERATURES. Prydz, Svein; Meloe, T. B.; Koren, J. F.; Eriksen, E. L. (Univ. of Oslo, Blindern, Norway). Anal. Chem.; 42: 156-61(Feb 1970).

Relative scintillation yields were measured under electron excitation (^3H-glucose) from 0° to −190°C. Scintillators tested included ethanol, acetone, benzene, anthracene, PPO, and Nuclear Enterprise types NE-214, NE-231, and NE-240. The use of benzene at −190°C is suggested for the detection of tritium (and other radionuclides) in thin-layer radiochromatography by the action of β-radioluminescence. The method should be applicable to film as well as photomultiplier detection. The sensitivity seems to be very high and the method is "noncontaminating" because the benzene can be completely evaporated at the end of the measurement. The freezing technique is still somewhat destructive to a few thin-layer preparations because of cracking during the cooling. However, this can perhaps be prevented. The temperature dependency observed in the β-radioluminescence of anthracene and PPO, when using photomultiplier detection, is much smaller than reported by others using film detection. (auth)

11455 AMOUNT AND DISTRIBUTION OF RADIONUCLIDES IN THE POTATO PLANT. Paulus, K. (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). Z. Lebensm.-Untersuch. Forsch.; 131: 80-9(1966). (In German).

The radioactive contamination of potatoes and other foods from fallout in Germany during 1964 is reported. Methods of radiochemical analysis of the potato plants for ^{90}Sr and ^{137}Cs are described. The ratio of ^{137}Cs to ^{90}Sr in the plant foliage was 6.9 and in the potato the ratio was 15. Analysis of the plant material showed the presence of 36, 250, 500, 600, <100, and <100 pCi/Kg of ^{90}Sr, ^{137}Cs, ^{144}Ce, ^{106}Ru, ^{54}Mn, and ^{155}Eu, respectively. The potatoes contained only ^{90}Sr and ^{137}Cs. The amounts decreased sharply from the outside to the inner portions of the potatoes. Only 15% as much ^{137}Cs activity was found in the peel as in the plant materials, and the ^{90}Sr activity in peel was only 7% of that in the plant. Over 60% of the ^{90}Sr activity in the potato was located in the peel, while the remainder was found within the potato substance. The ^{90}Sr activity was distributed like the concentration of Ca, while the ^{137}Cs distribution resembled the K distribution. (BBB)

11456 THIN-LAYER CHROMATOGRAPHIC SEPARATION ON LAYERS HEAVILY LOADED WITH POWDERED SCINTILLATORS FOR LUMINESCENCE DETECTION OF RADIONUCLIDES. Landmark, L. H. (Central Inst. for Industrial Research, Oslo); Hognestad, A. K.; Prydz, S. J. Chromatogr.; 46: 267-73(4 Feb 1970).

Experiments are reported demonstrating that interference is not necessarily caused in a chromatographic separation on standard thin layers by the admixture of powdered scintillators. The study is of importance in connection with a sensitive method of radionuclide detection by β-radioluminescence (either scintillation fluorography on photographic film material or by direct photoelectric detection). Kieselguhr-, silica gel-, and cellulose thin layers were prepared containing various proportions of either an inorganic or organic scintillator (zinc silicate or anthracene, respectively). Mixtures of carbohydrates, phospholipids, and amino acids were tested as representative systems with suitable layers and developing solvents. (auth)

11457 ENHANCED PHOTOEMULSION SENSITIVITY AT LOW TEMPERATURES USED IN RADIOCHROMATOGRAPHY. Koren, J. F.; Meloe, T. B.; Prydz, S. (Univ. of Oslo). J. Chromatogr.; 46: 129-31(7 Jan 1970).

Some experiments are reported concerning a previously reported method of detecting tritium and radiocarbon in thin-layer radiochromatography by adding scintillator to the thin-layer media, thus converting the small β particles into light. Experiments were conducted to explain why upon lowering the temperature from 20 to −78°C an increase in detection sensitivity less than 5% was found for photomultiplier detection, while for photographic detection a factor of ca. 25 is quoted for the sensitivity increase. It was concluded that by exposure at −78°C rather than at 20°C, the emulsion sensitivity is increased eighty times if the photons are randomly distributed in space and time, and also the more uneven the distribution of the photons in space and time (depending on the speed of the scintillator) the less temperature-dependent the emulsion sensitivity will be. (D.H.M.)

11458 BORON DETERMINATION IN NICKEL COATINGS BY NEUTRON ABSORPTION METHOD. Dillinger, Pavel (Slovak Technical Univ., Bratislava); Toelgyessy, Juraj; Kubik, Ctirad. Jad. Energ.; 16: 27-8(1970). (In Czech).

Results of investigations of the presence of boron in electrolytic nickel coatings by the neutron absorption method are presented. It was proved that the possible maximum boron content was under 0.2 mg/cm^2. Thus, boric acid forms a buffer solution in the electrolytic deposition of nickel. (auth)

11459 ISOTOPIC DETERMINATION OF INTESTINAL CALCIUM ABSORPTION IN NORMAL SUBJECTS. Mautalen, Carlos A.; Cabrejas, Mariana L.; Soto, Roberto J. (Instituto Investigaciones Medicas, Buenos Aires). Metab. Clin. Exp.; 18: 395-405(May 1969).

True gastrointestinal absorption of ^{45}Ca and ^{47}Ca was measured in a group of normal subjects employing simultaneously 3 different methods: the cumulative fecal excretion, and the double isotope ratio in plasma and urine between orally administered ^{47}Ca and intravenously injected ^{45}Ca. The measurement of ^{45}Ca fecal excretion was used to correct endogenous contribution to ^{47}Ca fecal content. The radiochemical procedures for measurement of the ^{45}Ca and ^{47}Ca, and the experimental procedures and the calculation formulas for evaluation of the true absorption values were described in detail. The results obtained showed that the 3 methods were equally reliable in the assessment of radiocalcium absorption. On the other hand, peak plasma values of oral ^{47}Ca did not reflect accurately the true gastrointestinal absorption of the isotope. The results observed by other workers were revised and summarized, and the establishment of a provisional normal reference standard for radiocalcium absorption was explored. (BBB)

11460 AMOUNT OF ^{199}Au in ^{198}Au. Nakamura, Haruto; Yamabayashi, Hisamichi (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi; 11: 721-5(1969). (In Japanese).

Several detection systems available for the routine measurement of ^{199}Au in ^{198}Au after irradiation were compared with each other in respect to efficiency, resolution, detecting sensitivity, and ease of maintenance. Gamma ray spectrometry using a NaI (Tl) crystal detector was found to be the most suitable for its relative ease in operation and maintenance. This method was applied to the measurement of ^{199}Au formed in gold at various positions in a reactor. The experimental results agreed well with those calculated by adopting the value of 2.58×10^4 barns as the reaction cross section for $^{198}Au(n,\gamma)^{199}Au$. Neutrons in the resonance region were found to not take part in the transformation of ^{198}Au into ^{199}Au. (auth)

11461 THE GAMMA-SPECTROMETRIC DETERMINATION OF $^{241}Pu/^{239}Pu$ RATIOS AND ITS APPLICATION TO FUEL BURN-UP. Peter, J.; Schumacher, H. (Swiss Federal Inst. for Reactor Research, Wuerenlingen). J. Nucl. Energy; 23: 617-23(Dec 1969).

High-resolution gamma spectrometry was applied to determine the $^{241}Pu/^{239}Pu$ isotopic ratios in plutonium-bearing fuels. The photopeaks at 129, 148, and 208 keV were utilized. From the $^{241}Pu/^{239}Pu$ ratio, the integrated neutron flux and the burnup can be calculated. The method was tested by comparing the results obtained from uranium and plutonium ratios in a Pu/U fuel. (auth) (UK)

11462 ANALYSIS BY RELEASE OF RADIOACTIVITY BY INORGANIC ION-EXCHANGE AND RING OVEN TECHNIQUE. I. DETERMINATION OF COPPER. Krivan, V. (Univ., Freiburg i. B.). Talanta; 16: 1513-18(Dec 1969).

A sparingly soluble inorganic compound, fixed as a spot on filter paper, is used as an ion-exchanger in which the exchangeable ions are labeled with a radioactive isotope. These ions are replaced by the ions of the element to be determined but not by other accompanying ions. In this exchange an equivalent amount of the radioactive labeled ions is released from the ion-exchanger and separated from the spot by the ring oven technique. The activity of the ring is measured and compared with that of a standard processed in the same way. The determination of copper in amounts greater than 25 ng in the presence of a similar amount of lead and considerably greater amounts of cobalt, nickel, zinc, manganese, and thallium is described. (auth) (UK)

Activation Procedures

Refer also to abstract 11764.

11463 (AED-C-14-4) BIBLIOGRAPHIES IN NUCLEAR SCIENCE AND TECHNOLOGY. SECTION 14: ACTIVATION ANALYSIS. Bock-Werthmann, W.; Niebuhr, H.; Sansoni, B. (comps.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Oct 1969. 325p. (In several languages). Dep. CFSTI (U. S. Sales Only). ZAED.

References (1293) on activation analysis are given to reports, conferences, journals, books, dissertations, and patents published from 1934 through 1964. Report number and conference indexes have been omitted since reports are listed alphanumerically and conference papers alphabetically corresponding to the place of conference. Separate indexes are included for author, element determined, material analyzed, and method. (P.C.H.)

11464 (AWRE-O-54/69) INTERIM REPORT ON THE MULTI-ELEMENT ANALYSIS OF GLASS FRAGMENTS BY NEUTRON ACTIVATION AND THE APPLICATION TO FORENSIC SCIENCE. Goode, G. C.; Wood, G. A.; Coleman, R. F. (Atomic Weapons Research Establishment, Aldermaston (England)). Nov 1969. 32p. Dep. CFSTI (U. S. Sales Only). UK 5s.

Methods for the multielement analysis of glass fragments using thermal neutron activation and γ spectrometry are described. A representative collection of window-glass samples from England and Wales has been obtained from scenes of fires and 200 of these were analyzed. A preliminary assessment of the discrimination of the technique for forensic examination is attempted and a comparison with physical methods made. (auth)

11465 (IEA-INF-9) ACTIVATION ANALYSIS AND CONTROL OF MATERIALS OF HIGH PURITY. Lima, Fausto W. (Instituto de Energia Atomica, Sao Paulo (Brazil)). Sep 1967. 13p. (In Portuguese). Dep. CFSTI (U. S. Sales Only).

The importance of production and stocking of materials consisting of chemical elements of almost absolute purity is explained and the need for their use in nuclear industry, modern electronics, and the production of semiconductors demonstrated. These materials require analytical methods for the determination of impurities of the order of 1 ppM or even 1 ppB since such materials, for instance semiconductors, lose their characteristics, if they contain extremely small amounts of certain impurities. Principles and techniques of activation analysis are examined. The advantages of this method are shown, particularly avoidance of contamination of matrix with those elements of which traces should be determined. For this reason activation analysis must be considered the best analytical method for extremely small impurity concentrations, though it could also be applied in the field of usual impurity percentages. It constitutes a special field of analytical chemistry such as are other branches as for instance analysis of extremely dilute solutions or electrochemical analysis. Important examples are given showing the application of this method in metallurgy, geology, electronics, and nuclear materials. (F.J.W.)

11466 PRECISE DETERMINATION OF OXYGEN AND SILICON IN CHONDRITIC METEORITES BY 14-MeV NEUTRON ACTIVATION WITH A SINGLE TRANSFER SYSTEM. Morgan, J. W.; Ehmann, W. D. (Univ. of Kentucky, Lexington). Anal. Chim. Acta; 49: 287-99(Feb 1970).

Improved methods for the determination of oxygen and silicon by 14-MeV neutron activation are described. A single-transfer system is employed to attain a precision approaching that of biaxial rotator systems. Analyses of six samples of the Allende chondrite are given and a correlation is found between oxygen and silicon abundances. (auth)

11467 APPLICATION OF NEUTRON ACTIVATION ANALYSIS TO THE SWEAT TEST DIAGNOSIS OF CYSTIC FIBROSIS. McAndrew, Robert G. (Texas A and M Univ., College Station); Smathers, James B.; Wainerdi, Richard E.; Harrison, G. M.; Doggett, Robert. Nucl. Appl. Technol.; 8: 290-5(Mar 1970).

Using neutron activation analysis, (NAA), the sodium to potassium ratio as well as the sodium concentration was determined for both normal and cystic fibrosis patients. The ratio results correlate with those based on the accepted sodium concentration analysis in the diagnosis of cystic fibrosis and the results also confirm calculations that the sensitivity of the NAA ratio method is a function of neutron energy with the optimum neutron energy being about 1.2 MeV. The coupling of the ratio technique with NAA greatly increases the possibility of performing a successful "sweat test" on an infant and offers the following benefits: Reduction in required sample volume by at least a factor of three due to the increased sensitivity of NAA; elimination of the necessity to know the amount of sweat, again allowing the use of a smaller sample; and elimination of the errors inherent in the present concentration analysis method such as evaporation, electrolytes present from previous perspiration, and variation of electrolyte concentration with sweat rate. (auth)

11468 VOID-SPACE ANALYSIS BY USE OF THERMAL-NEUTRON IRRADIATED AIR (^{41}Ar). Champlin, Jerry B. F. (Georgia Inst. of Tech., Atlanta). Nucl. Appl. Technol.; 8: 283-9(Mar 1970).

The void space in a variety of objects can be obtained by a neutron activation method utilizing the normal argon content in the air filling the pores and voids of such samples. The activation reaction used is $^{40}Ar(n,\gamma)^{41}Ar$ which has a cross section of 0.63 barn. ^{41}Ar decays by beta emission with a half life of 1.83 hours to the stable isotope of potassium, ^{41}K. If the quantity of air in a sealed container is known, the air can be used as an activation "foil" to estimate the total flux seen by the sample while in the reactor. After standard air-volumes are evaluated, porous solids containing air can be analyzed for void space if placed under the same conditions of geometry and efficiency and the activity acquired used as a measure of the total air present relative to a standard. It is possible to use this technique with substances for which the porosity (void space bulk volume) is difficult to measure in other ways. (auth)

11469 AUTOMATION AND INSTRUMENTATION. Proceedings of the VIII International Convention, Milan, 19th–25th November, 1964. Dadda, Luigi; Pellegrini, Umberto (eds.). Milan; Tamburini Editore (1967). 741p. $22.50. (In several languages). (CONF-641138).

Fifty-six papers are presented under the headings control theory, information processing, computer process control, electronic techniques, telemetry, measurement techniques, radioactivation analysis, and miscellaneous applications in industrial instrumentation. Separate abstracts were prepared for 10 papers. (M.C.G.)

For abstracts of individual papers see: 11470–11476 and 13498–13500.

11470 AUTOMATED SYSTEMS FOR NUCLEAR ACTIVATION ANALYSIS. Wainerdi, R. E.; Fite, L. E. (Texas A and M Univ., College Station). pp 557-68 of Automation and Instrumentation. /Dadda, Luigi (ed.). Milan; Tamburini Editore (1967).

From 8th International Convention on Automation and Instrumentation, Milan, Italy. See CONF-641138.

A program was undertaken to demonstrate the feasibility applying automation and computer methods to instrumental activation analysis. The grouping of activating source, spectrometer, and data processor developed under this program consists of a nuclear reactor, an automated gamma spectrometer, and sample transfer system (called the Mark I-Ia) coupled to an IBM 709 computer. The Mark I-Ia System served as the prototype for a more sophisticated and higher capacity automated spectrometer, called the Mark II System, which was recently completed. A small 14-MeV neutron activation analysis system, adaptable for industrial process control purposes, is now under development. (auth)

11471 ACTIVATION ANALYSIS BY MEANS OF 14-MeV NEUTRONS. Laverlochere, J. (CEN, Grenoble, France). pp 569-76 of Automation and Instrumentation. /Dadda, Luigi (ed.). Milan; Tamburini Editore (1967). (In French).

From 8th International Convention on Automation and Instrumentation, Milan, Italy. See CONF-641138.

Experiments carried out aim at enhancing the selectivity of this analytical method, at extending its possible applications, and at putting activation facilities within easy reach of research workers. First attention was focused on the possibility of applying this technique to the measurement of oxygen in a dozen matrices and on sensitivity limits due to interferences caused by the matrices. Secondly, the activation of 50 elements by these neutrons was investigated and sensitivities were measured by a 150 KV industrial accelerator. Finally, production of strong fluxes of 14-MeV neutrons was investigated as well as some aspects of analysis accuracy and rapidity in view of the construction of a high-sensitivity automatic unit. (auth)

11472 POSSIBILITIES OF AUTOMATIC DETERMINATION BY ACTIVATION ANALYSIS OF CERTAIN TRACE ELEMENTS IN BIOLOGICAL LIQUIDS. Comar, D.; Le Poec, C. (CEA, Orsay, France). pp 577-86 of Automation and Instrumentation. /Dadda, Luigi (ed.). Milan; Tamburini Editore (1967). (In French).

From 8th International Convention on Automation and Instrumentation, Milan, Italy. See CONF-641138.

Investigations of human metabolism often require a great number of measurements of the same element in a biological medium. Activation analysis offers such valuable services in this field that the possibility of continuous automatic determination of trace elements was envisaged. Not only are automatic systems very quick, they also reduce personnel requirements and minimize irradiation dangers. Schemes are described for the determination of blood and urine iodine and urine copper; some preliminary results of sample irradiation by means of slow neutrons and chemical treatments using automatic equipment presently on the market are also illustrated. (auth)

11473 ACTIVATION ANALYSIS AND COMPUTERS. Meloni, S. (Univ., Pavia, Italy). pp 587-93 of Automation and Instrumentation. /Dadda, Luigi (ed.). Milan; Tamburini Editore (1967).

From 8th International Convention on Automation and Instrumentation, Milan, Italy. See CONF-641138.

An IBM electronic computer program for resolution of composite decay curves of radioactive nuclides is described. It is codified in FORTRAN and analyzes decay curves by the least-squares method. The versatility of such a program is shown by the different subprograms allowing, for example, an accurate determination of the half-lives of unknown activities, subtraction of the activity of a known component, and the possibility of discarding points above set values of the standard deviation. An example is given of the application of such a program to the determination of nickel in high-purity platinum by means of neutron activation. (auth)

11474 NEUTRON ACTIVATION SEMI-AUTOMATED SYSTEM FOR THE DETERMINATION OF TRACE ELEMENTS. Girardi, F.; Guzzi, G.; Pauly, J. (Joint Nuclear Research Center, Ispra, Italy). pp 594-9 of Automation and Instrumentation. /Dadda, Luigi (ed.). Milan; Tamburini Editore (1967).

From 8th International Convention on Automation and Instrumentation, Milan, Italy. See CONF-641138.

A semiautomated system for the determination of trace elements is described. It consists of: a radioactivation stage by irradiation in the Ispra I Reactor, a radiochemical separation step whose full automation is presently under study, a stage of radioactivity measurement by gamma spectrometry, and treatment of experimental data by means of IBM 7090 and IBM 1620 electronic computers. By this system the processing of a great number of samples is made possible. For its flexibility the procedure can be applied to the solution of a large variety of problems. (auth)

11475 ANALYZER–COMPUTERS SYSTEM FOR RADIOACTIVATION ANALYSIS. Bonsignori, C. (LABEN, Milan); Granucci, G.; Pellegrini, U. pp 600-13 of Automation and Instrumentation. /Dadda, Luigi (ed.). Milan; Tamburini Editore (1967).

From 8th International Convention on Automation and Instrumentation, Milan, Italy. See CONF-641138.

An analytical system capable of recording data from a number of radioactive sources, by subdividing a 4096 word memory into all possible binary subgroups until it is possible to record simultaneously the spectra from 64 sources, each one in a group of 64 channels, is described. The logical design of the address and content register of the memory allows the data stored in a memory subgroup to be recorded while new data are being accumulated simultaneously in other memory subgroups: this recording operation can also be switched to enable transfer of the data to the memory of a general purpose on-line computer or to a magnetic tape recorder. The recorder system is equipped with a special purpose computer with fixed program, which can be preselected by means of switches. Computation programs are selected to perform the specific processing operations to be undertaken on nuclear spectra. An original method of standardization of the energy axis of measured or computed spectra is illustrated. (auth)

11476 APPLICATION OF RADIOACTIVE METHODS TO ANALYSIS AND TO THE CONTROL OF MANUFACTURING. Martinelli, P. (CEN, Saclay, France). pp 622-31 of Automation and Instrumentation. /Dadda, Luigi (ed.). Milan; Tamburini Editore (1967). (In French).

From 8th International Convention on Automation and Instrumentation, Milan, Italy. See CONF-641138.

Radioactive isotopes find a wide field of application in industrial production. Radioactive analysis methods are classified into three main groups: method based on specific radiations emitted by the investigated element itself, either because it is radioactive or by secondary emission; methods based on radiation absorption or diffusion; or methods using isotopes as reagents or tracers. Among the methods of the first group activation analysis and x-ray fluorescence analysis are mentioned. The second group includes absorption measurement methods and back scattering. The third group includes methods based on isotope dilution analysis and radiometric chemical analysis. Examples are given for each group. The application of radioactive isotopes to the problems of measuring the thickness of sheets or of coatings and of defect detection are discussed. (auth)

11477 CADMIUM DETERMINATION IN BIOLOGICAL TISSUE BY NEUTRON ACTIVATION ANALYSIS. Lieberman, K. W.; Kramer, H. H. (Union Carbide Corp., Tuxedo, N. Y.). Anal. Chem.; 42: 266-7(Feb 1970).

A neutron activation method is described for the determination of cadmium in biological tissues using the nuclear reaction $^{114}Cd(n,\gamma)^{115}Cd$. The expected accuracy of the method is about 5% and practical lower limit of detection is 50 ppB Cd when using a neutron flux of 1×10^{13} n/cm^2/sec, an irradiation period of 100 hours, and a decay period of 4 days. (D.H.M.)

11478 NEUTRON ACTIVATION ANALYSIS OF THORIUM IN ROCKS AND ORES BY MULTIPLE γ-RAY PEAK RATIO DETERMINATION. Mantel, Mariana; Sung-Tung, Propai; Amiel, Saadia (Soreq Nuclear Research Centre, Yavne, Israel). Anal. Chem.; 42: 267-71(Feb 1970).

An attempt to develop a method for the assay of ^{233}Pa by calculating a series of self-consistent gamma peak ratios is reported. The method offers high specificity and accuracy even in very complex matrices. The procedure was applied to the determination of

thorium in standard ores and in rock samples. The overall precision of ±2.5% for a single measurement is most satisfactory for an activation analysis method. (D.H.M.)

11479 FEATURES OF THE MODIFIED COVELL METHOD FOR COMPUTATION OF TOTAL ABSORPTION PEAK AREAS IN COMPLEX GAMMA-RAY SPECTRA. Sterlinski, Slawomir (Inst. of Nuclear Research, Warsaw). Anal. Chem.; 42: 151-5 (Feb 1970).

Results of an investigation of the features of the modified Covell method for comparison of the total absorption peak areas in nondestructive activation analysis are described. Either a small computer or an ordinary calculator can be used. The method proposed gives a better evaluation of the precision of the peak area in a complex gamma-ray spectrum than the traditional method of Covell. The predominance of this method over that of Covell is demonstrated especially in the case of a high ratio of the height of baseline to the peak height; i.e., for small peaks appearing on a high background. (auth)

11480 PREPARATION OF ISOTOPIC OXYGEN TARGETS FOR CHARGED PARTICLE ACTIVATION ANALYSIS. Lamb, James F.; Lee, Diana M.; Markowitz, Samuel S. (Univ. of California, Berkeley). Anal. Chem.; 42: 209-12(Feb 1970).

A method was developed for the preparation of oxygen comparison standards for charged particle activation analysis, particularly for the use of ^{3}He as the activating particle, by anodic oxidation of tantalum foil. The isotopic composition of the oxide is varied by using isotopically enriched water in the electrolyte, which is 0.1% potassium chloride. The current passing through the cell is held constant at 40 mA while the voltage is allowed to vary. The thickness of the oxide film produced is a smooth function of time and is reproducible to within a few percent. Oxide films were produced which vary in thickness from 0.5 mg/cm^2 for a 1-minute anodization, to over 35 mg/cm^2 for an anodization time of 3 hours. The uniformity of the anodized foil and the oxygen content were verified by ^{3}He activation analysis. Standards for activation analysis may be made by this method which will reproduce any beam degradation in a sample from negligible energy loss to the complete stopping of a 10-MeV ^{3}He beam. These standards were used for isotopic oxygen analysis of several materials and for measuring excitation functions for the production of ^{18}O and ^{19}F from ^{18}O and for production of ^{18}F, ^{16}O, ^{11}C, and ^{17}F plus ^{14}O from ^{16}O. (auth)

11481 INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS OF ATMOSPHERIC POLLUTANTS UTILIZING Ge(Li) γ-RAY DETECTORS. Zoller, W. H.; Gordon, G. E. (Massachusetts Inst. of Tech., Cambridge). Anal. Chem.; 42: 257-65(Feb 1970).

Instrumental neutron activation analysis employing lithium-drifted Ge γ-ray detectors was used to measure the concentrations of more than 20 elements (mostly metals) in atmospheric aerosols of urban areas. For most elements studied, the technique is more sensitive and accurate than techniques in current use. The method is very convenient and is quite fast for several elements having short-lived irradiation products (Al, V, Mn, Na, Cl, Br). The technique can also be used to measure the concentrations of many of the elements in important pollution source materials. (auth)

11482 DEVELOPMENT AND CHARACTERIZATION OF ION-EXCHANGE BEAD MICROSTANDARDS. Freeman, David H.; Currie, Lloyd A.; Kuehner, Edwin C.; Dixon, Herbert D.; Paulson, Rolf A. (National Bureau of Standards, Washington, D. C.). Anal. Chem.; 42: 203-9(Feb 1970).

The encapsulation of Na or Ca by ion exchange beads is investigated in the counterion mass range below one nanogram. Preparative methods are described for obtaining the exchanger in a pure counterion form and for subsequent prevention of ion exchange so that the isolation of a single bead is possible in the absence of significant contamination. Activation analysis indicated that the network heterogeneity was characterized by a 5% relative standard deviation for Na in measurements extending to 3×10^{-12} grams. A bead diameter measurement is equivalent to a counterion mass determination and this opens the door to the use of the beads as microstandards in the mass region where no other methods are applicable. (auth)

11483 DETERMINATION OF VANDIUM IN DEPOSIT AND AIRBORNE PARTICULATE BY NEUTRON ACTIVATION ANALYSIS. Bando, Shoji; Imahashi, Tsuyoshi (Atomic Energy Research Inst., Ibaraki, Japan). Jap. Anal.; 18: 1477-82(Dec 1969). (In Japanese).

A method of neutron activation analysis was developed for the determination of trace amounts of vanadium in deposits and in airborne particulates. The sample was irradiated for 2 min. in JRR-1 (3×10^{11} n/cm^2·sec) and fused with sodium hydroxide. Vanadium was extracted from pH~4 solution into chloroform. The energy of ^{52}V was measured and corrected for chemical yield. The time for a determination was about 10 min. The proposed method is simple, rapid, and applicable to as little as 0.03 μg of vanadium both in deposits and airborne particulates. (auth)

11484 NEUTRON ACTIVATION ANALYTICAL ESTIMATION OF COBALT AND CALCIUM IN EXPERIMENTAL CARDIAC FAILURE CAUSED BY COBALTOUS CHLORIDE. Kasperek, K.; Siller, V.; Knieriem, H. J. (Kernforschungsanlage, Juelich, Ger.). Z. Gesam. Exp. Med.; 150: 316-24(6 Aug 1969). (In German).

Using neutron activation analysis, Co and Ca concentrations in the myocardium and myocardial mitochondria of the rat were evaluated. The neutron flux used was 7×10^{13} neutrons/cm^2 sec. After an irradiation time of 1 hr, the activities of ^{60m}Co and ^{60}Co were 300 and 5.88×10^{-3} Ci/g. The activities of the Ca radioisotopes produced after irradiation for 1 min were for ^{41}Ca, ^{45}Ca, ^{47}Ca, ^{49}Ca, 73×10^{-12}, 1.2×10^{-6}, 21.8×10^{-6}, and 3.9×10^{-5} Ci/g, respectively. The detection limit for the Co in the samples was ~10^{-10} g. Because ^{60}Co was so long lived as compared to the other radioisotopes produced, the short and medium half-life radioisotopes did not interfere with estimation of the Co concentrations in the samples. The limit of detection sensitivity of the described neutron activation analysis for Co was ~2×10^{-9} g. The detection sensitivity could have been improved by a factor of 10^2 or 10^3 if the Na and Cl in the samples had been removed before they were irradiated with neutrons. (BBB)

11485 A SYSTEM FOR THE NEUTRON ACTIVATION ANALYSIS OF TRACE ELEMENTS IN SAMPLES OF BIOLOGICAL AND ENVIRONMENTAL INTEREST. Edgington, David N.; Lucas, Henry F. Jr. Argonne Nat. Lab. Rev.; 5: 98-105(Oct 1969).

Determination of trace amounts of elements by neutron activation methods is discussed. Nondestructive and destructive methods are considered and examples are given. Data analysis is described. (M.C.G.)

11486 DETECTION OF A REPEATED THALLIUM POISONING BY MEANS OF NEUTRON ACTIVATION ANALYSIS OF HAIR AND NAILS. Henke, G. (Westfaelische Wilhelms-Univ., Muenster, Ger.). Arch. Toxikol.; 25: 48-56(19 Jun 1969). (In German).

For evaluation by neutron activation analysis of Tl incorporated into hair and nails of a patient, hair samples of 200 to 300 mg and 9 to 10 cm long were made into bundles, and toenail samples consisting of a 3 × 20 mm section were placed in quartz ampules. These samples and a Tl standard solution were irradiated in a reactor for 24 hr with a thermal neutron flux of 5×10^{12} n/cm^2 sec. Details of the chemical procedures used for treatment of the irradiated samples to remove radioactive contaminants are described. Carrier solution used in the purification process contained 1 mg each of ionic As, Au, Br, Cd, Co, Cr, Cu, Fe, Hg, La, Sb, Sr, Zn, and Sn. The purified samples were counted by measurement of the ^{204}Tl produced in the samples by the neutron irradiation. The measurements showed 2 distinct peaks of Tl incorporation into the hair and nails. These correlated well with the 2 periods of time within 11 months that the patient was known to have incorporated Tl, taking into consideration the growth rate of hair and nails and their normal concentration of Tl. (BBB)

11487 MULTI-TRACE ELEMENT NEUTRON ACTIVATION ANALYSIS USING CHEMICAL SEPARATIONS AND HIGH-RESOLUTION GAMMA-RAY SPECTROSCOPY. Peterson, Stephen Frank. Ithaca, N. Y.; Cornell Univ. (1969). 103p. Thesis.

Two approaches to the inability of neutron activation analysis to resolve complex mixtures of radiations in analysis of trace elements are presented. The first approach utilizes chemical separation of irradiated complex samples into groups, followed by high resolution gamma spectroscopy. This allows the resolution of spectra that are extremely complex and the determination of more elements than can be done by strictly instrumental means. The second approach involves rapid radiochemical separations and is particularly suited to matrix removal for the analysis of short half-life isotopes. The utility and scope of neutron activation analysis were extended through these methods. (Diss. Abstr.)

11488 HIGH-RESOLUTION GAMMA-RAY SPECTROMETRY IN THE DETERMINATION OF TRACE ELEMENTS IN HUMAN FINGERNAILS. Petushkov, A. A.; Linekin, D. M.; Balcius, J. F.; Brownell, G. L. (Massachusetts General Hospital, Boston). J. Nucl. Med.; 10: 730-1(Dec 1969).

Neutron activation and γ spectrometry were used to determine Na, Bi, Au, Zn, and Sb in human fingernails. (M.C.G.)

11489 STUDIES ON METALS IN AIR POLLUTION. 2. ALUMINUM AND MANGANESE AMOUNTS IN DEPOSITS MEASURED BY RADIOACTIVATION ANALYSIS AND THEIR SEASONAL AND GEOMETRICAL VARIATIONS. Yamane, Yasuhiro; Miyazaki,

Motoichi (Chiba Univ., Japan). Eisei Kagaku; 15: 238-43 (Aug 1969). (In Japanese).

Measurements by radioactivation analysis were carried out for Al and Mn in deposits, collected from various sampling points in Chiba areas. From the analytical data, the seasonal and geometrical fluctuations of the amount of Al or Mn in the deposits were also determined. The deposits were collected monthly for a year, and each 10 mg ash of the deposit was irradiated for 1 min at neutron flux, 3×10^{10} n/cm^2·sec, (5 kw) for Al, and 8×10^{13} n/cm^2·sec, (10 Mwt) for Mn, respectively, and their γ spectra were analyzed, (Al: 1.78 MeV, Mn: 0.83 MeV). The values of Al obtained by this method agreed well with the ones reported previously, which were determined by the ordinary chemical analysis. (NSA of Japan)

11490 FUNDAMENTAL PREMISES OF THE GAMMA-ACTIVATION METHOD OF DETERMINING THE CARBON AND OXYGEN CONTENT IN COAL SAMPLES. Sulin, V. V. Tr., Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 1, 244-55(1968). (In Russian).

Examination of the possibilities of using the γ activation method to analyze coals for H, O, and other elements shows that H and O differ in their γ activation characteristics from one another and also from the other major elements in coals, and thus can be determined in a coal mass of complex composition. Use of serially produced laboratory betatrons for such analysis can provide the sensitivity necessary for solving geologic and other analytical problems. The main variants of the γ activation method to be used against backgrounds of various elements other than H and O are listed. (Geophys. Abstr.)

11491 RESULTS OF TESTING OF THE GAMMA-ACTIVATION METHOD OF DETERMINING THE HYDROGEN AND OXYGEN CONTENT IN COAL SAMPLES. Belov, V. I.; Berzin, A. K.; Vitozhents, G. Ch.; Sulin, V. V. Tr., Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 1, 255-66(1968). (In Russian).

Some results of tests of γ-activation analysis of coal samples for H and O content, carried out to solve procedural problems in the practical execution of that type of analysis are examined. The accuracy of the method is comparable to that of chemical analysis. These experimental results demonstrate the practical possibility and expediency of using the γ-activation method as a method of analyzing samples of coal and other substances of complex composition for hydrogen and oxygen in the laboratory. (Geophys. Abstr.)

11492 POSSIBILITIES OF USING THE GAMMA ACTIVATION METHOD FOR QUANTITATIVE DETERMINATION OF THE ZIRCONIUM CONTENT IN SAMPLES OF ZIRCONIUM ORES AND CONCENTRATES. Berzin, A. K.; Vitozhents, G. Ch.; Sulin, V. V. Tr., Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 1, 266-74(1968). (In Russian).

The possibility of the practical use of the γ activation method for rapid laboratory analysis of Zr ores, concentrates, and other substrates for Zr is demonstrated. By using modern high concentration γ quantum generators, automatically conveying the samples to irradiation, and measuring with several simultaneously operating complexes of apparatus, the accuracy, sensitivity, and efficiency of this type of analysis can be substantially increased. (Geophys. Abstr.)

11493 ON THE PROBLEM OF USING THE GAMMA ACTIVATION METHOD FOR SIMULTANEOUS DETERMINATION OF THE ZIRCONIUM AND TITANIUM CONTENT IN COMPLEX TITANO-ZIRCONIUM ORES. Shornikov, S. I. Tr., Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 1, 274-9 (1968). (In Russian).

Some results of work on the simultaneous determination of Ti and Zr in samples of complex Ti-Zr ores by the γ activation method are presented. In a first series of experiments, a peak of γ radiation of ^{47}Sc with energies of 0.160 MeV (the product of photoproton reaction on ^{48}Ti) and peaks of γ radiation of ^{95}Zr with energies of 0.511 MeV and 0.913 MeV (the product of photoneutron reactions on ^{90}Zr) are clearly distinguished in the spectrum. In a second series of tests, peaks corresponding to ^{28}Al and ^{29}Al with energies of 1.78 and 1.28 MeV (products of photoneutron reactions on ^{28}Si and ^{30}Si) and peaks corresponding to ^{89m}Zr with energies of 1.50 and 0.59 MeV (from reactions on ^{90}Zr) are distinguished in the spectrum; with secondary recording of the spectrum about 40 min after irradiation, when practically all the ^{89m}Zr has decayed, the value of induced activity obtained is governed entirely by decay of ^{45}Ti. (Geophys. Abstr.)

11494 INVESTIGATION OF ROCKS BY THE METHOD OF ACTIVATION OF OXYGEN NUCLEI BY NEUTRONS WITH ENERGIES OF 14 MeV. Zaporozhets, V. M.; Kedrov, A. I. Tr., Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 1, 182-92 (1968). (In Russian).

The possibilities of exploratory investigations of rocks by activation of oxygen nuclei by neutrons with energies of 14 MeV are discussed. Estimates of the depth of penetration of such investigations, attempts to activate rocks in boreholes, and a description of the apparatus used are included. (Geophys. Abstr.)

11495 INSTRUMENTAL ANALYSIS OF NEUTRON-IRRADIATED SOILS. Kline, J. R.; Brar, S. S. (Argonne National Lab., Ill.). Isotop. Radiat. Technol.; 7: 319-24(Spring 1970).

Neutron-activated soils from a worldwide collection were analyzed by gamma spectrometry to identify and measure trace elements that can be studied by this technique and to determine whether gamma spectra of soils can be used to identify specimens of soil and trace them to their geographical origin. Samples of 100-mg size were irradiated for either 5 or 10 min in the Argonne CP-5 Reactor at a thermal-neutron flux of 2×10^{13} n/(cm^2)(sec). Nuclides with half-lives shorter than 15 hr were not measured. Long-lived nuclides, which could be observed after 4 days' delay are ^{140}La, ^{46}Sc, ^{82}Br, ^{59}Fe, ^{51}Cr, ^{60}Co, ^{152}Eu, ^{154}Eu, ^{153}Sm, ^{181}Hf, and ^{95}Zr-^{95}Nb. Quantitative nondestructive determinations were easily made for La, Sc, Fe, Co, Eu, and Sm. Amounts of scandium were correlated with amounts of iron, cobalt, and europium in soils of highly diverse origin. Similar correlations were not obtained with lanthanum. Elemental relationships sometimes resulted in similar gamma-ray spectra for soils of dissimilar origin. These spectra, therefore, raised doubts as to whether they could be used without other supporting evidence to identify soil specimens or trace them to their place of origin when the analysis is done with NaI crystals and 400-channel analyzers. (auth)

11496 RAPID INSTRUMENTAL NUCLEAR ACTIVATION ANALYSIS OF ROCKS, CEMENTS, AND METEORITES. Wyttenbach, A. (Eidgenoessische Technische Hochschule, Wuerenlingen, Switzerland). Helv. Chim. Acta; 52: 2458-65(10 Dec 1969).

The experimental setup and the method for γ-spectrum analysis as used in the activation analysis of rocks, cements, and meteorites by reactor neutrons are discussed. Rapid nondestructive simultaneous determination of several elements is possible. Fractional percent reproducibility is possible for Al, Na, and Mn; the determination of Ca, Mg, and V in the samples studied is influenced by the Al and Mn content, but reproducibility approaches 1% in favorable cases. Accuracy is generally within the limits set by the reproducibility. The minimum weight of the sample is small (10 to 40 mg), but the grain-size must be below 150 mesh; in the case of meteorites, a grain-size effect was demonstrated. Representative results for several standard rocks and cements, for 7 L-chondrites, 2 hyperstene achondrites, and separate mineral phases of the Elenovka are given. (auth)

11497 ACTIVATION ANALYSIS OF ROCKS FOR STRONTIUM AND BARIUM USING A SEMICONDUCTOR DETECTOR. Hamaguchi, Hiroshi (Tokyo Univ.). Bunseki Kiki; 7: 703-7(Nov 1969). (In Japanese).

Activation analysis, using a semiconductor detector, for strontium and barium, was carried out on the following rocks supplied by the U. S. Geological Survey: G-1 (granite), W-1 (Diabase), G-2 (granite), GSP-1 (granite-diorite), AGV-1 (andesite), and BCR-1 (Basalt). The rock was irradiated in a reactor (1.5×10^{12} n/cm^2/sec) for one hour. The detector used was a Li-drifted detector with effective capacity of 9.6 ml. Before using the detector coupled with a pulse-height analyzer, the sample of rocks, together with the standard sample, was subjected to group (Sr and Ba) chemical precipitation for separation. For BCR-1 in particular, the gamma spectra of Sr and Ba for the sample and the standard were in fair agreement. For the six rocks, the amount of Sr and Ba detected in two analyses agreed well within the experimental error. Also the values showed good agreement with previously reported values. The sensitivity of detection by the method was 10 ppM for strontium and 5 ppM for barium, and its applicability to various significant rocks on the earth was demonstrated. (NSA of Japan)

11498 A SELECTIVE METHOD FOR THE COMPLETE REMOVAL OF SODIUM FROM SAMPLES IN ACTIVATION ANALYSIS. de Wet, W. J. (National Nuclear Research Centre, Pelindaba, South Africa). J. S. Afr. Chem. Inst.; 22: 168-74(Sep 1969).

A problem encountered in neutron activation analysis of geological, biological, and other samples, utilizing γ spectrometry, is the inability to measure short-lived activities (half-lives up to 1 day) after reactor irradiation, when overwhelming ^{24}Na($t_{\frac{1}{2}}$ = 15 hr) activity is present. The method described for the complete removal of sodium from samples in activation analysis is suitable for remote application. The principle of the method is based on

the observation that mainly sodium cations (and to a lesser extent potassium cations) are electrolizable through ordinary Pyrex glass membranes at elevated temperatures. Gold, copper, silver, and thallium cations undergo only negligible migration. Free sodium in activation analysis samples can therefore be removed selectively by means of the experimental arrangements described. Subsequently, potassium can also be removed if necessary, but only at a rate between $1/_{19}$ to $1/_{29}$ of that for sodium. This method may also be applied to the determination of potassium and sodium by activation analysis, in particular for the concentration and extraction of these elements after activation of samples in which they are present in low concentrations. Other analytical applications of the method are apparent; for instance, the removal of an excess of alkali salts from dissolution melts, which is often troublesome in many analytical procedures. The method is useful for the production of ^{22}Na and ^{24}Na as solid radioisotopic sources, and for their carrier-free separation from target materials after irradiation. (BBB)

11499 DETERMINATION OF TRACES OF HAFNIUM IN ALUMINUM BY NEUTRON ACTIVATION ANALYSIS. Balsenc, L.; Haerdi, W. (Univ., Geneva). Helv. Chim. Acta; 52: 2657-62(10 Dec 1969). (In French).

Three methods are proposed for assay of traces of hafnium in aluminum metal by neutron activation analysis. In the first method, the isotope ^{179m}Hf(T = 19 s), produced is counted after anionic resin exchange separation in sulfuric acid medium. The two other methods, which are nondestructive, are based on the formation of ^{180m}Hf(T = 5.5 h) and ^{178m}Hf(T = 19 s). The latter method comprises an instrumental separation. (auth)

11500 DETERMINATION OF CHLORINE IN SELENIUM BY INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS. Braetter, P.; Roesick, U.; Lutze, W. (Hahn-Meitner Inst., Berlin). Solid State Commun.; 8: 129-32(Jan 1970).

A nondestructive determination of chlorine traces in selenium by means of a large volume Ge(Li) detector for high-resolution γ-spectrometry is described. The nuclide used for detection is ^{38}Cl. The calculated limit of detection is 0.8 ppM. (auth) (UK)

11501 DETERMINATION AND DIFFUSION OF OXYGEN IN GaAs. Rachmann, J.; Biermann, R. (Siemens Schuckertwerke AG, Munich). Solid State Commun.; 7: 1771-5(Dec 1969). (In German).

The oxygen content of GaAs single crystals grown under a protective B_2O_3 melt by the liquid encapsulation technique was determined by mass spectrometry, deuteron and neutron activation analysis and was found to be 10^{19} to 10^{20} atoms cm^{-3}. Crystals grown from the melt by other techniques as well as vapour- and solution-grown epitaxial layers were found to have concentrations of the same order of magnitude. An estimate from mass-spectrometric data yields an effective diffusion coefficient of oxygen in GaAs of $D_{eff} = 2 \times 10^{-3} \exp(-1.1\ eV/kT)\ cm^2\ s^{-1}$ between 700 and 900°C. (auth) (UK)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 11437, 11501, 11604, 11628, 11649, 11658, 11670, 11672, 11689, 12348, 13544, and 13561.

11502 (CEA-N-1148, pp 125-32) ELECTROCHEMICAL STUDIES. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Developments are reported for studies on: electrochemistry of fused salts and electrocrystallization; and studies and uses of electrolytic coatings. (P.C.H.)

11503 (CEA-R-3924) CHLORINE PENTAFLUORIDE. Bougon, Roland (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jan 1970. 54p. (In French). Dep. CFSTI (U. S. Sales Only).

This study on chlorine pentafluoride includes a bibliography of articles published up to July 1969. Some original data from studies on this subject are gathered. (auth)

11504 (COO-2026-1) KINETICS OF METHYLENE AND HYDROXYL RADICAL REACTIONS. Technical Progress Report. Carr, Robert W. Jr. (Minnesota Univ., Minneapolis. Dept. of Chemical Engineering). [1969]. Contract AT(11-1)-2026. 9p.

The photolysis of ketene and ketene-d_2 in the presence of propane and a number of inert gases (He, Ar, Xe, N_2, CF_4) was studied. Studies showed that methylene in the first excited state from this reaction can be converted to the triplet ground state by inelastic collisions. Intersystem crossing in singlet methylene-d_2 was 2 to 3 times faster than in CH_2. A tubular quartz discharge-flow apparatus for studying hydroxyl radical reactions was built and tested. Reactions of OH were studied. A pulsed nitrogen laser was built for photolysis studies. (M.C.G.)

11505 (IA-1190, pp 133-81) INORGANIC AND APPLIED CHEMISTRY. (Israel Atomic Energy Commission, Tel Aviv).

Research in this field was centered mainly on electrode processes, nonaqueous solvent chemistry (molten salts and HF), problems relating to desalination, and the thermodynamic properties of electrolyte solutions. Work on electrode processes included electrodeposition (e.g., tantalum), anodic oxidation (niobium, zirconium), electrolytic machining (fuel elements) and the production of bromine by electrolysis. In much of this work nonaqueous media were used, e.g., molten borates or nitrates, and acetonitrile. Some applications of electroless plating were also studied, as well as the polarographic reduction of tungsten and the tungsten-catalyzed polarographic reduction of chlorate. In addition to their use as a medium for electrolysis, molten salts were also used in solvent extraction studies. Stability constants of complexes and reaction rates for their formation in molten nitrate and thiocyanate were determined. The solvent properties of liquid hydrogen fluoride were also investigated. Studies of the properties of electrolyte solutions included determination of activity coefficients by isopiestic and osmometric measurements, determination of molal volumes in mixed electrolyte solutions, and salting-in or salting-out of ketones in concentrated aqueous solution. Among other topics investigated are the complex chemistry of americium, and the oxidation of phosphine by water in a mass spectrometer. Work on problems of sea water desalination included hard scale prevention by elimination of either calcium or sulfate, prevention of soft scale and corrosion by use of SO_2, and general corrosion studies. Use of ion exchange membranes for removal of divalent cations from sea or brackish water was investigated. A model for active transport across a membrane was analyzed. Possible recovery of some elements (e.g., boron) from sea water during desalination was another topic studied. A preliminary feasibility study of a nuclear desalting-power-industrial complex as well as of a nuclear electrochemical complex was carried out. (auth)

11506 (IA-1190, pp 183-9) SPECTROSCOPY AND SPECTROCHEMICAL ANALYSIS. (Israel Atomic Energy Commission, Tel Aviv).

Work was continued on the description of rare earth spectra and interpretation of the energy levels. Special attention was paid to the infrared photographic region. In the field of spectrochemical analysis the laboratory continued to provide analytical services to various customers, and in addition carried out some analyses of geological standard rocks for minor constituents. (auth)

11507 (INR-1071) THE STRUCTURE AND SOME PROPERTIES OF URANYL SALT COMPLEXES WITH UREA AND ITS ALKYL DERIVATIVES. An Infrared Study. Deptula, Andrzej (Institute of Nuclear Research, Warsaw (Poland)). 1969. 42p. Dep. CFSTI (U. S. Sales Only).

It was found that in uranyl nitrate, chloride, sulfate, perchlorate, and oxalate complexes, the urea and its alkyl derivatives are coordinated through the oxygen atom of the carbonyl group and that the relative strength of the UO_2^{2+} ← ligand linkage, decreases in the series TMU > 1,3-DMU ≥ 1,3-DEU > Ur > MU > EU > H_2O, where TMU = tetramethylurea; 1,3-DMU = 1,3-dimethylurea; 1,3 DEU = 1,3-diethylurea; Ur = urea, MU = methylurea; and EU = ethylurea. The types of anion coordination were also established. It was observed that free anions occur exclusively in the structure of uranyl perchlorate complexes, of uranyl nitrate complexes containing more than two organic ligands per molecule, and in the $UO_2Cl_2 \cdot 5(1,3\text{-DMU})$ complex. In all complexes of uranyl sulfate and of the remaining uranyl salts containing more than two organic ligands per molecule (except for $UO_2(ClO_4)_2 \cdot 5Ur$), the occurrence of hydrogen bonds between anions (free or coordinated) and NH_2 (or NH) groups of the ligands was established, the relative bond strength being proportional to the effective charge of the acceptor atom. (auth)

11508 (ORO-672, pp 107-21) PROPERTIES OF CLAY SYSTEMS CONTROLLING ION EXCHANGE KINETICS AND ION EXCHANGE EQUILIBRIUM. Gast, R. G.; Deshpande, K. B. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

Progress is reported for studies of exchange between alkali metal cations on montmorillonites and selectivity studies on Chambers montmorillonite (ΔG° and ΔH° values). Ion exchange equilibria of alkaline earth cations on Wyoming bentonite were also investigated. Data are presented in graphic and tabular form. The differences between the behavior of alkali metal cations and alkaline earth metal cations was that the alkali metal pairs showed a distinct

gradient of selectivities whereas the alkaline earth cation pairs did not. (C.O.)

11509 (SC-R-69-1386) FUSED SALT MIXTURES: SPECIFIC CONDUCTIVITY TABLES. Clark, Paul V. (Sandia Labs., Albuquerque, N. Mex.). Oct 1969. 433p. Dep. CFSTI.

This work was undertaken to meet a need in Sandia Laboratories for ready access to the data in the literature of fused salt chemistry. It was begun with a search of Chemical Abstracts from 1907 through 1962. The initial emphasis was on mixtures with eutectic points in the range from 200 to 500°C. This limitation was abandoned in 1964 and the current coverage includes all apparently reliable data up through August, 1968. Eutectic data were published in Fused Salt Mixtures: Eutectic Compositions and Melting Points, SC-R-68-1680, December, 1968. In these tables specific conductance values for some 270 fused salt systems are presented as a function of composition and temperature. In a majority of cases, a system will have been reported only once. However, in instances of multiple reports, each seemingly reliable report was included. The value of an added case, though the data may be limited, is apparent. The organization of the systems follows that used for Eutectic Compositions and Melting Points, although all groups will not be represented in this report. The systems are written in alphabetical order by formula and all two-component systems report the percentage of the first component only. (auth)

11510 CONCENTRATION OF RADIOACTIVE IODIDE SOLUTIONS. Muenze, R.; Gens, J.; Guethert, A. (Zentralinstituts fuer Kernforschung, Rossendorf, Ger.). Isotopenpraxis; 5: 382-3(Sep-Oct 1969). (In German).

The adsorption of iodide ions on platinum surfaces and desorption into a smaller solution volume by polarization of the electrode is discussed. (M.C.G.)

11511 THE CRYSTAL STRUCTURE OF AMMONIUM THORIUM(IV) OCTAFLUORIDE, $(NH_4)_4ThF_8$. Ryan, R. R.; Penneman, R. A.; Rosenzweig, A. (Los Alamos Scientific Lab., N. Mex.). Acta Crystallogr., Sect. B; 25: 1958-62(1969).

Crystals of $(NH_4)_4ThF_8$ are triclinic, space group $P\bar{1}$, with a = 8.477(10), b = 8.364(8), c = 7.308(7) Å, $\alpha = 88°23'(3')$, $\beta = 96°5'(3')$, $\gamma = 106°20'(3')$, Z = 2, $D_x = 3.06$, $D_m = 3.08$ g cm^{-3}. Each thorium atom has nine fluorine neighbors at an average distance of 2.38 Å; the polyhedron is a distorted trigonal prism with the three equatorial fluorine ions approximately normal to the face centers. The polyhedra are joined into infinite chains paralleling the b axis by sharing two edges in each polyhedron. The remaining fluoride ion is not involved in the coordination sphere of thorium; the closest thorium atom to this fluoride ion is at a distance of 4.98 Å. This fluoride ion is coordinated to five ammonium ions which are in approximately a square pyramidal configuration. (Denmark)

11512 THERMODYNAMICS OF THE ACTINIDE ELEMENTS. PART I. HEATS OF FORMATION OF CRYSTALLINE NEPTUNIUM TETRACHLORIDE, NEPTUNIUM OXIDE DICHLORIDE, AND NEPTUNIUM TRIOXIDE MONOHYDRATE, AND A NEW DETERMINATION OF THE HEAT OF FORMATION OF THE Np(III) AND Np(IV) IONS IN M-HYDROCHLORIC ACID. Fuger, J. (Univ., Liege); Brown, D.; Easey, J. F. Contract 011-64-6 TPUB. J. Chem. Soc., A; 19: 2995-3002(1969).

The following heats of solution have been measured: neptunium metal in oxygen-free 1M-HCl, to yield Np(III) – 126.2 ± 0.2 kcal mole^{-1}; neptunium metal in 1M-HCl – 0.005M-Na_2SiF_6 to yield Np(IV), –166.0 ± 0.2 kcal mole^{-1}; $NpCl_4$ in 1M-HCl and 1M-HCl – 0.005M-Na_2SiF_6, –53.87 ± 0.13 and –54.40 ± 0.10 kcal mole^{-1}, respectively; $NpOCl_2$ in 1M-HCl, –33.64 ± 0.12 kcal mole^{-1}; NpO_3, H_2O in 1M-HCl and 1M-$HClO_4$, –12.70 ± 0.10 and –12.85 ± 0.10 kcal mole^{-1}, respectively. On combination with other thermodynamic data, these results yield the following heats of formation at 298°K. Np(III) in 1M-HCl, –126.2 ± 0.2; Np(IV) in 1M-HCl, –132.3 ± 0.3; $NpCl_4$, –236.0 ± 0.3; $NpOCl_2$, –245.8 ± 0.3 and NpO_3, H_2O, –332.4, all in kcal mole^{-1}. (auth) (UK)

11513 HIGH TEMPERATURE rH/pH DIAGRAMS FOR THE SYSTEM URANIUM(VI) NITRATE-WATER. Edenborough, B. W.; Robins, R. G. (Univ. of New South Wales, Kensington). Electrochim. Acta; 14: 1285-95(Dec 1969).

A method of calculating thermodynamic equilibrium relationships in the system U(VI)nitrate–water up to 300°C is presented, and rH/pH diagrams are constructed for temperatures of 25, 60, 100, 150, 200, and 300°C. The method involves the use of the correspondence principle and takes into account activity/concentration relationships and the effects of added nitric acid. (auth) (UK)

11514 REFINEMENT OF THE CRYSTAL STRUCTURE OF β_1–K_2UF_8. Brunton, George (Oak Ridge National Lab., Tenn.). Acta Crystallogr., Sect. B; 25: 2163-4(1969).

Single crystals of β_1–K_2UF_8 were selected for a redetermination of the structure given by Zachariasen in 1948 from powder data. The structure was found to be essentially as described with only small differences in the old and new interatomic distances. (Denmark)

11515 Zr AND UF_6: NEW PRODUCTS FOR ELDORADO NUCLEAR. Craigen, W. J. S. (Eldorado Nuclear Ltd., Ottawa); Joe, E. G.; Ritcey, G. M. Chem. Can.; 42-5(Dec 1969).

The new process involves the conversion of zircon sand to a sodium zirconate frit, dissolution of this in nitric acid, separation of the zirconyl nitrate from the hafnyl nitrate in a tributyl phosphate solvent extraction system, production of ZrF_4 and its subsequent reduction to nuclear grade metal. Flowsheets for both Zr and UF_6 are given. (F.S.A.)

11516 REFINEMENT OF THE CRYSTAL STRUCTURE OF $ThCl_4$. Mucker, Kenneth; Smith, Gordon S.; Johnson, Quintin; Elson, R. E. (Univ. of California, Livermore). Acta Crystallogr., Sect. B; 25: 2362-5(1969).

The crystal structure of $ThCl_4$ was determined by Mooney [Acta Cryst. (1949) 2, 189] from x-ray diffraction powder data. Each Th atom was found to be dodecahedrally coordinated, the Th–Cl bond distances falling into two sets, 2.46 (4×) and 3.11 Å (4×). This crystal structure was refined using diffractometrically recorded intensities from a single crystal. The crystals are tetragonal, a = 8.48$_8$, c = 7.46$_5$ Å; the space group is $I4_1/amd$. The calculated density for four molecules of $ThCl_4$ per unit cell is 4.62 g cm^{-3}. Full-matrix, least-squares refinement resulted in an R index of 3.8% (anisotropic temperature parameters) and in significant shifts in the positional parameters. The two sets of Th–Cl bond distances now become much more nearly equal: 2.718 ± 0.008 (4×) and 2.903 ± 0.007 Å (4×). The angles that these bond directions make with the $\bar{4}$ axis of the dodecahedron are 78.0° and 33.1°, respectively. No evidence was found to support the claim of Takeuchi & Obata [Nuclear Sci. Abstr. (1967) 21, 856] that this tetragonal phase is actually a hydrated form. (auth)

11517 BEHAVIOUR OF HYDROGEN ELECTRODE IN H_2O + D_2O MIXTURES. Gold, V. (King's Coll., London); Lowe, B. M. Trans. Faraday Soc.; 65: 3037-41(Nov 1969).

A theoretical equation for the variation with solvent deuterium atom fraction n of the standard cmf $E^\ominus$ of a cell containing the hydrogen gas and silver/silver chloride electrodes was derived and tested against the experimental results of Noonan and La Mer. The comparison was used to estimate the equilibrium constants for the reactions $H_2O(g) + HD(g) = HDO(g) + H_2(g)$, and $HDO(g) + D_2(g) = D_2O(g) + HD(g)$. (auth) (UK)

11518 CATALYSIS OF THE NITROGEN ISOTOPE EQUILIBRATION REACTION BY RHENIUM. Boon, C.; Gasser, R. P. H.; Tovey, H. (Physical Chemistry Lab., Oxford). Trans. Faraday Soc.; 65: 3111-14(Nov 1969).

Isotope scrambling experiments have been used to confirm that nitrogen is adsorbed dissociatively by rhenium. At temperatures above ca 800 K a rhenium filament acted as a catalyst for the isotope exchange reaction $^{28}N_2 + {}^{30}N_2 = 2{}^{29}N_2$. The maximum efficiency was ca 0.03%. No evidence was found for participation of processes occurring within the bulk of the metal. (auth) (UK)

11519 157th ACS NATIONAL MEETING, MINNEAPOLIS, MINNESOTA, APRIL 13–18, 1969. ABSTRACTS OF PAPERS. Washington, D. C.; American Chemical Society (1969). 480p. $4.00. (CONF-690402-(Absts.)).

11520 REACTION KINETICS OF SOME ACTINIDE OXALATES BY DIFFERENTIAL THERMAL ANALYSIS. Subramanian, M. S.; Singh, R. N.; Sharma, H. D. (Bhabha Atomic Research Centre, Bombay). J. Inorg. Nucl. Chem.; 31: 3789-95(Dec 1969).

Kinetic parameters such as the energy of activation and order of reaction for the stepwise thermal decomposition in air of the hydrated oxalates of Th(IV), U(IV), Np(IV), Pu(IV), Pu(VI), and Pu(III) have been evaluated by differential thermal analysis. The heats of reaction involved in the various stages of the decomposition have been determined from the peak areas of the DTA curves. The dehydration of the tetravalent hydrated oxalates excepting Np(IV) oxalate gave rise to a major endothermic peak followed by a smaller endotherm which could actually involve a partial decomposition also. The oxidation of the anhydrous oxalates gave a single exothermic peak. (auth) (UK)

11521 STUDY ON COMPLEXES OF Fe^{3+}, Cu^{2+}, AND UO_2^{2+} WITH BENZANILIDOXIME. Manoussakis, G.; Kouimtzis, Th. (Univ. of Thessaloniki, Greece). J. Inorg. Nucl. Chem.; 31: 3851-4(Dec 1969).

The formation constants of the complexes that form between

benzanilidoxime and Fe^{3+}, Cu^{2+} and UO_2^{2+} ions have been measured at 25°C in aqueous and mixed aqueous dioxan solutions. The complexes $Fe(L_2)OH$, $Cu(L_2)$, and $UO_2(L_2)$ have been isolated. The structures of these compounds have been established by means of uv, ir, ^1H NMR spectra, and elemental analysis. (auth) (UK)

11522 LOW-CONCENTRATION SOLUTIONS OF HYDROGEN AND DEUTERIUM IN α-HAFNIUM. Ricca, Franco (Univ. of Turin); Giorgi, Tiziano A. J. Phys. Chem.; 74: 143-6(8 Jan 1970).

The pressures of hydrogen and deuterium in equilibrium with their solutions in α-hafnium were measured in an ultrahigh-vacuum system, over the temperature interval from 275 to 845°C and for atom ratios from $\sim 5 \times 10^{-5}$ to $\sim 5 \times 10^{-4}$. The solutions were found to follow Sievert's law. Constant relative partial molal enthalpies of −8.60 kcal/g-atom and −8.77 kcal/g-atom were determined for hydrogen and deuterium, respectively. Also the relative partial molal entropies were proved to be essentially independent of temperature. The entropy data lead to the exclusion of strict localization of hydrogen and deuterium in the tetrahedrally coordinated interstitial sites within the lattice. (auth)

11523 EFFECT OF BRANCHING INDUCED BY GAMMA RADIATION ON POLYVINYL CHLORIDE. Palma, G.; Pezzin, G.; Zaramella, S. Chim. Ind. (Milan); 51: 1240-4(1969). (In Italian).

By exposing to γ-rays high concentration solutions of PVC in the THF, crosslinks are produced in the macromolecules (yield value G_c 1.5) giving rise to branched macromolecules of higher molecular weight. With the branched polymers obtained, the intrinsic viscosity $[\eta]$ and the viscosity in high concentration solutions η are found lower than the corresponding values with the linear polymers of equal molecular weight M_w. The dependence of $[\eta]$ and η on M_w in the branched polymers is discussed on the ground of the equations reported in the literature. (auth)

11524 REACTION OF AMMONIUM TRICARBONATOURANYLATE SOLUTIONS WITH SYNTHETIC HYDROXYAPATITE. Tarantsova, M. I.; Nikolskaya, Yu. P. (Novosibirsk Inst. of Physical and Chemical Ore Treatment, USSR). Izv. Sib. Otd. Akad. Nauk SSSR; No. 12, Ser. Khim. Nauk, No. 5, 77-84(Sep 1969). (In Russian).

The products of the reaction of ammonium tricarbonatouranylate (indexed to ammonium uranyl carbonates) solution with synthetic hydroxylapatite were investigated by means of x-ray powder diffraction, thermography, chemical analysis, and ir spectroscopy. The reaction affords a new chemical compound, hydrogen autunite. (auth)

11525 PHASE DIAGRAM OF THE SYSTEM ZIRCONIUM TETRAHYDROBORATE–DIOXANE. Volkov, V. V.; Myakishev, K. G.; Bagryantsev, G. I. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR; No. 12, Ser. Khim. Nauk, No. 5, 144-6(Sep 1969). (In Russian).

Mutual solubility in the system zirconium tetrahydroborate–dioxane was studied by low temperature differential thermal analysis. It was established that this sytem is a simple eutectic. The eutectic point corresponds to the temperature −4°C and 40 mole % zirconium tetrahydroborate. (auth)

11526 PROBLEMES DE STRUCTURE ET PROCESSUS DE TRANSPORT DANS LES SOLUTIONS ELECTROLYTIQUES CONCENTREES ET LES SELS FONDUS. 19e Reunion de la Societe de Chimie Physique, Montpellier, [France], 17 au 20 Septembre 1968. (Problems of Structure and Transport Processes in Concentrated Solutions of Electrolytes and in Fused Salts. 19th Meeting of the Chemical Physics Society, Montpellier, France, 17–20 September 1968). J. Chim. Phys.; Special No., 1-216 (Oct 1969). (CONF-680968).

Twenty-eight papers presented at the conference are included. A separate abstract was prepared for one paper. (M.C.G.)

For an abstract of one paper see: 11527.

11527 EXPERIMENTAL INVESTIGATIONS ON THE ACTIVITY AND THE ION TRANSPORT IN CONCENTRATED ELECTROLYTIC SOLUTIONS. Schwabe, Kurt (Technische Univ., Dresden). J. Chim. Phys.; Special No., 205-14(Oct. 1969). (In German).

From 19th Meeting on Structure and Transport Processes in Concentrated Electrolytic Solutions and Molten Salts, Montpellier, France. See CONF-680968.

Measurements of activity coefficients by chain voltage at constant concentrations of the potential-determining electrolytes and at growing concentration of external salts, show an increase in relation to the external salt concentration, which in many cases follows the equation: $\log f_\pm = \log f_{\pm 0} + K.m_s$, ($m_s$ = molality of the external salt). The constant K decreases with growing cation radius of the external salt and may reach negative values. The exponential rise of $f_\pm$ with the salt concentration is first due to f_+, while f_- changes relatively less. (auth)

11528 PRECIPITATION OF PLUTONIUM(IV) WITH SODIUM METAVANADATE. Watanabe, Kenju; Sagawa, Chiaki (Japan Atomic Energy Research Inst., Tokai). Nippon Kagaku Zasshi; 90: 1127-9(Nov 1969). (In Japanese).

The precipitation of plutonium(IV) with sodium metavanadate was studied in an acetate-buffered solution. The optimum conditions of the precipitation were 0.1 to 0.5 mol/l sodium acetate solutions of pH 2.0 to 4.5 containing plutonium(IV) and sodium metavanadate in the mole ratio of 1 : 2 to 5. The mole ratio of V to Pu in the precipitate obtained under the conditions was within the range from 1.9 to 2.2. (NSA of Japan)

11529 HOMOGENEOUS ISOTOPE EXCHANGE REACTION: $^{32}O_2 + {}^{36}O_2 = 2{}^{34}O_2$. Carroll, Harvey Franklin. Ithaca, N. Y.; Cornell Univ. (1969). 135p.

Thesis.

The homogeneous atom switching reaction between $^{32}O_2$ and $^{36}O_2$, highly diluted in Ar, was studied behind the reflected shock in a single pulse shock tube over the temperature range of 1150 to 1600°K and a total density range of 1×10^{-2} to 4.5×10^{-2} moles/l. Oxygen mole fractions varied from 0.0005 to 0.02. The $^{36}O_2$ gas was prepared by electrolysing 97.59 atom % ^{18}O water. Dilute mixtures of O and Ar were prepared in a glass high vacuum line. A mass spectrometer was used for analysis. The data could not distinguish between two empirical rate laws: $d[^{16}O^{18}O]/dt = 3 \times 10^{11} \exp(-35.0 \pm 3.0)/RT\ [^{16}O^{16}O] - [^{18}O^{18}O]$ moles l^{-1} sec^{-1}; $d[^{16}O^{18}O]/dt = 4 \times 10^{9} \exp(-35.0 \pm 3.0)/RT\ ([^{16}O^{16}O] + [^{18}O^{18}O])^2$ moles l^{-1} sec^{-1}. Both rate expressions arise from a two level vibrational excitation model when slightly different assumptions are introduced. Neither set of assumptions agrees with the reported vibrational relaxation times for O–Ar collisions, but does agree with the values reported for O–O collisions. The possible reasons for this disagreement are presented and the difference between the O exchange and other homogeneous exchanges is discussed, including the formation of O_4 dimers. (Disser. Abstr.)

11530 SECONDARY DEUTERIUM ISOTOPE EFFECTS IN ALLYLIC REARRANGEMENTS. Korver, Gailerd Lee. Pullman, Wash.; Washington State Univ. (1969). 71p.

Thesis.

Allyl phenyl ether, allyl-1,1-d_2 phenyl ether, and allyl-3,3-d_2 phenyl ether were synthesized. The kinetics of the ortho-Claisen rearrangement were followed by monitoring the disappearance of allyl phenyl ether (or either of its dideuterated isomers) with a gas chromatograph. The rate constants were obtained at 170.0, 184.8, and 194.6°C by an exponential least-squares treatment of the rate data. The isotope effects determined at 185°C and 1.09 (per D) for the rearrangements of allyl phenyl ether and allyl-1,1-d_2 phenyl ether and 0.97 (per D) for the rearrangements of allyl phenyl ether and allyl-3,3-d_2 phenyl ether. These results were consistent with a transition state in which the degree of tetrahedral to trigonal conversion that occurs at the α-carbon of the allylic system is greater than the amount of trigonal to tetrahedral conversion occurring at the γ-carbon. These effects can also be interpreted to mean that the α-carbon has a substantial amount of product character in the transition state whereas the γ-carbon is still reactant-like in that its geometry has not changed significantly in reaching the transition state. The results were interpreted by comparing them with reported isotope effects for complete sp^3 to sp^2 changes and complete sp^2 to sp^3 conversions and also by comparing them with predicted isotope effects for the same complete changes in geometry. The isotope effects are thought to reflect the changes in vibrational frequencies (C-H) that accompany complete tetrahedral to trigonal or trigonal to tetrahedral conversions. (Disser. Abstr.)

11531 BASE-CATALYZED HYDROGEN–DEUTERIUM EXCHANGES OF SOME SIX-MEMBERED HETEROAROMATIC COMPOUNDS. Monroe, Elizabeth McLeister. Urbana, Ill.; Univ. of Illinois (1969). 113p.

Thesis.

1-Thia-4-pyrone was found to exchange H-2 and H-6 for D in basic D_2O or methanol-d solutions. The position of exchange was determined by comparison with the NMR chemical shifts and the exchange behavior of 3,5-dimethyl-1-thia-4-pyrone and 2,6-dimethyl-1-thia-4-pyrone. Kinetic studies indicated that this exchange was first order in substrate and in base with a combined solvent-kinetic isotope effect of ca. 2 in aqueous solutions. Further analysis indicated that dideuteration occurred via two consecutive first order reactions. Several attempts to trap a carbanion of 1-thia-4-pyrone in non-hydroxylic media were unsuccessful. The kinetics of exchange of H-6 of N-methyl-2-pyridone were studied. This process also was found to be first order in substrate and in base in sodium deuteroxide in D_2O at

100°C. The rates of exchange of H-2 and H-6 of 4-methoxythiopyrylium fluoroborate and of 4-methoxy-1-methylpyridinium fluoroborate were studied in anhydrous methanol-d solutions and appeared to be first order in substrate and in base. Deuteration of 1-methyl-4-pyrimidone and 3-methyl-4-pyrimidone at C-2 in D_2O at 100°C was studied in buffered solutions at pD 5, 7, and 10 and was found to be first order in substrate but zero order in base as reported. Exchange of 1,3-dimethyl-4-pyrimidonium fluoroborate, a cationic analog of the N-methyl-4-pyrimidones, at C-2 was first order in substrate and in base in acetate buffered D_2O at ca. 40°C. For the compounds that had exchange reactions first order in base, the rates of exchange relative to that reported for N-methyl-4-pyridone (D_2O, 100°C), are: 1-Thia-4-pyrone, $10^{4.3}$ (D_2O at 100°C); N-methyl-2-pyridone, $10^{-9.8}$ (D_2O at 100°C); 4-methoxythiopyrylium fluoroborate, $10^{4.3}$ (methanol-d at 40°), 4-methoxy-1-methylpyridinium fluoroborate, $10^{5.4}$ (methanol-d at 40°); and 1,3-dimethyl-4-pyrimidonium fluoroborate, $10^{10.1}$ (D_2O at 40°). The results of these exchange studies are interpreted qualitatively in terms of yield intermediates. (Disser. Abstr.)

11532 KINETICS OF METHYL IODIDE–IODINE EXCHANGE IN SHOCK TUBE. Kassman, Allen Jay. Ames, Iowa; Iowa State Univ. (1969). 101p. (IS-T-274).

Thesis.

The homogeneous gas phase isotopic exchange of methyl iodide and iodine was studied in the single-pulse shock tube in the temperature range 870 to 1105°K. The exchange was monitored by tagging molecular iodine with ^{131}I tracer. The observed rate of exchange was in agreement with the following mechanism: $M + I_2 \underset{r}{\overset{k_d}{\rightleftharpoons}} 2I + M$, and $I + CH_3I \; 1 \rightleftharpoons 2\,CH_3 + I_2$, where M is the inert carrier gas, in the present case Ar. The rate constants k_d and k_r were taken from the shock tube data of other workers on the three-body recombination rate. The isotopic exchange reaction allowed a determination of k_1 as follows: k_1 (cc/mole-sec) = $10^{13.9}$ exp (–20.0 kcal/RT). This value of k_1 is slightly lower than its determination by other workers as the rate determining step of the reaction $CH_3I + HI \rightleftharpoons CH_4 + I_2$. It is, however, within the experimental error for a more acceptable value of the Arrhenius factor of 14.1 to 14.2. (Disser. Abstr.)

11533 DETERMINATION BY X-RAY DIFFRACTION OF α UO_3 IN COMPLEX MIXTURES OF OXIDES OF THE β UO_3 FAMILY. Nicolas-Jarleton, Jacques; Legrand, Charles (CEA, Ballancourt, France. CNRS, Bellevue, France). Compt. Rend., Ser. C; 269: 1101-3(12 Nov 1969). (In French).

In the course of reactions carried out on uranium metal, it was found that the reactivity of the intermediate UO_2 phase depends on the content of uranium in α-UO_3. A method for the determination by x-ray diffraction of this oxide has been worked out that permits determination up to a content of 1.5%. (tr-auth)

11534 POTASSIUM POLYURANATES. Anderson, J. S. (Oxford Univ.). Chimia (Aarau); 23: 438-44(11 Dec 1969).

A reinvestigation of the system K_2O-UO_3 by diffraction methods and ir spectroscopy shows that there are two well defined polyuranate phases. Both are based structurally on layers of uranium in hexagonal array, as found in U_3O_8 and $K_2U_2O_7$. One polyuranate, isolated in crystalline form is of the diuranate type, with anionic layers 7.045 Å apart, the spacing determined by cation size and packing dimensions of the uranyl group. It has a composition near $K_2O \cdot 3UO_3$, but probably a more complex formula. The second, not isolated pure, has $K_2O : UO_3 < 1 : 8$, with the layers continuously linked through shared uranyl oxygen atoms, as in α-UO_3. The structural principles of these pseudo-hexagonal layer structures are discussed. (auth)

11535 THERMODYNAMICS OF SOLUTION OF SELECTED ELEMENTS IN LIQUID PLUTONIUM. Bowersox, D. F.; Leary, J. A. (Los Alamos Scientific Lab., N. Mex.). J. Nucl. Mater.; 33: 311-14(Dec 1969).

The thermodynamics of dissolution of W, Ta, Nb, V, Mo, and Cr in Pu were studied. Results of applications of ideal, empirical, and regular theories to liquid plutonium solutions are given. (M.C.G.)

11536 THE REACTION BETWEEN CO_2 AND LIQUID SODIUM. Cordfunke, E. H. P.; Ouweltjes, W. (Reactor Centrum Nederland, Petten, Netherlands). J. Nucl. Mater.; 33: 328-32(Dec 1969).

Preliminary experiments showed that when CO_2 was passed over liquid sodium a rapid reaction occurred at about 450°C; the heat liberated by this reaction was so large that liquid sodium burned violently in CO_2 at this temperature. Na_2CO_3 and carbon are formed in the reaction. The temperature at which the reaction started depended markedly on the purity of both sodium and CO_2. Reaction rates were measured. In static experiments, the sodium surface was rapidly covered by a layer of carbon, inhibiting the reaction strongly. (M.C.G.)

11537 THE FUSIBILITY DIAGRAM OF THE $PbCl_2$–$ThCl_4$ SYSTEM. Desyatnik, V. N.; Melinkov, Yu. T.; Raspopin, S. P.; Nichkov, I. F. Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 3, 99-100(1969). (In Russian).

The fusibility diagram of $PbCl_2$–$ThCl_4$ was constructed according to differential-thermal analysis. Results show that $PbCl_2$ forms two compounds with $ThCl_4$: $4PbCl_2 \cdot ThCl_4$ and $2PbCl_2 \cdot ThCl_4$. The system is characterized by three eutectic points: at 12.5 mole % $ThCl_4$ and 382°C, at 25.5 mole % $ThCl_4$ at 400°C, and at 48.5 mole % $ThCl_4$ at 376°C. (tr-auth)

11538 CERTAIN PECULIARITIES OF THE REACTION OF URANIUM DIOXIDE WITH CARBON IN VACUUM. Vlasov, V. G.; Revebtsov, B. B. Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 3, 105-9(1969). (In Russian).

Results of a study of the reduction of UO_2 by carbon in a vacuum are presented. Uranium dioxide was prepared by the decomposition of purified uranium peroxide in air at 1100°K for 6 hours with subsequent reduction of the decomposition product in a current of hydrogen at the same temperature for 8 hours. The final preparation had a brown color and the chemical composition of $UO_{2.09}$. (tr-auth)

11539 SURFACE ENTHALPY OF THORIA GEL. Bannister, M. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). J. Amer. Ceram. Soc.; 52: 675-6 (21 Dec 1969).

Differential thermal analysis (DTA) and thermogravimetric analysis (TGA) were used to investigate the evolution of volatile substances from thoria gel. The DTA patterns indicated that in addition to the endotherms associated with the loss of water and then nitric acid, there was a broad exotherm from 700 to 1250°C. Measurement and identification of this exotherm are described. The increase in heat release with increase in specific surface suggests a relation between the two. It is proposed that the exotherm is caused by the release of surface enthalpy from the gel, less than 5% remaining as grain boundary enthalpy. The mean surface enthalpy was 1100 ± 200 ergs/cm^2 (95% confidence limits). (J.G.B.)

11540 DIPHENYL SULPHOXIDE AND TRIPHENYL PHOSPHATE COMPLEXES OF URANIUM(VI) AND URANIUM(IV). Majumdar, A. K.; Bhattacharyya, R. G. (Jadarpur Univ., Calcutta). Chem. Ind. (London); No. 3, 95-6(17 Jan 1970).

The isolation and characterization by infrared spectra of some diphenyl sulphoxide complexes of uranium(VI) and uranium(IV) and a triphenyl phosphate complex of uranium(VI) are reported. Compositions with analytical results and some physical properties are listed. (auth) (UK)

Radiation and Nuclear Chemistry

Refer also to abstracts 11433, 11519, 11631, 11738, 11959, and 12912.

11541 (AECL-3511) INTRODUCTION OF THERMAL STABILITY AND OTHER CHARACTERISTICS TO NYLON MOULDING POWDER BY RADIATION INDUCED REACTIONS. DasGupta, Sharda (Atomic Energy of Canada, Ltd., Ottawa (Ontario). Commercial Products Div.). Nov 1969. 29p. (CPSR-189; CONF-690543-1). Dep. CFSTI (U. S. Sales Only). AECL $1.00.

From 27th Annual Technical Conference, Chicago, Ill.

Radioinduced reactions were used to graft styrene and acrylonitrile monomers onto nylon moulding powders to yield products superior to the starting material in many respects. Characteristics desired can be imparted by proper choice of monomer and extent of grafting. The more important properties achieved are stability to heat, resistance to chemicals, moisture, and radiation, and improved mouldability. The procedures for carrying out the reactions and the results of physical and chemical tests on the products are described. (auth)

11542 (AERE-R-6223) RADIATION-INITIATED FORMATION OF POLYSULPHONES IN SYSTEMS CONTAINING 1:3-BUTADIENE. Hills, P. R.; Rowe, R. J. (United Kingdom Atomic Energy Authority, Wantage (England). Research Group). Oct 1969. 15p. Dep. CFSTI (U. S. Sales Only). UK 3s.

High yields of polysulphones can be obtained in the sulphur dioxide–butadiene system in the presence of ionizing radiation. The product is formed by an efficient chain-reaction and G-values larger than 10^5 were observed. The polysulphones produced from butadiene and a number of mixed monomer systems have all proved intractable; no adequate solvent was found for them, and their high melting points preclude fabrication at elevated temperatures. The thermal stability of the polymers was also determined. (auth) (UK)

11543 (BARC–420) RADIATION INDUCED SULFOCHLORINATION OF HYDROCARBONS. Rao, K. N.; Moorthy, P. N. (Bhabha Atomic Research Centre, Bombay (India)). 1969. 12p. Dep. CFSTI (U. S. Sales Only).

The γ-induced sulfochlorination of kerosene, Shell-Sol, liquid paraffins, and dekalin with mixtures of sulfur dioxide and chlorine were investigated. The effects of time of irradiation and gas flow rate were studied. It was concluded that compared to sulfonation with fuming sulfuric acid, direct sulfochlorination with sulfur dioxide and chlorine should be cheaper and put less demands on construction materials. (D.H.M.)

11544 (BARC–446) RETHINKING IN RECOIL CHEMISTRY OF COBALT(III) COMPLEXES: A NEW INTERPRETATION. Venkateswarlu, K. S. (Bhabha Atomic Research Centre, Bombay (India)). 1969. 25p. Dep. CFSTI (U. S. Sales Only).

The recoil chemistry of cobalt complexes is discussed. Topics covered include: solid-state exchange and thermal annealing, exciton-induced exchange and annealing, role of oxygen carriers, effects of other ambients, effect of dilution, effect of hydration, radiation annealing, species in electrophoresis, and kinetics of annealing. (M.C.G.)

11545 (CEA-CONF–1414) TECHNOLOGY AND ECONOMY OF RADIOCHEMICAL GRAFTING IN VAPOR PHASE APPLIED TO TEXTILES. Candau, R.; Gaussens, G.; Lemaire, F.; Paoli, D.; Puig, J. R. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [1969]. 20p. (In French). (CONF-690805–10). Dep. CFSTI (U. S. Sales Only).

From Symposium on Utilization of Large Radiation Sources and Accelerators in Industrial Processing, Munich, Germany.

The equipment and method are described for grafting of irradiated polyester fibers in the presence of acrylic acid vapors. Studies were made on the capacity and rate of treatment as a function of the activity of the irradiation source. The economics of the method using a ^{60}Co γ source and accelerator electrons were compared. It was concluded that the method is not yet ready for industrial scale production. (P.C.H.)

11546 (CEA-R-3786) CONTRIBUTION TO THE STUDY OF THE CHEMICAL CONSEQUENCES OF THE (n,γ) REACTION IN SOLID Co(III) TRIS-AECTYLACETONATE. Magnane Machado, Ruy (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes (U.S. Sales Only).

Thesis. Submitted to Univ. of Grenoble, France.

The fragmentation and annealing of thermal neutron irradiated Co(III) tris-acetylacetone was investigated using the thin layer chromatographic technique (silica gel 1 mm thickness). Low temperature irradiations (0°C to –72°C and –180°C) lead to ^{60}Co retentions as low as (1.1 ± 0.2) %. Annealing by linear temperature programming at different heating rates has shown the existence of eight reactions. The influences of pile dose and of gases (air and helium) as well as of thermal decomposition on the annealing processes were confirmed. A temperature and dose dependent effect was found out for the retentions of the ^{60m}Co and ^{60}Co isomers. (auth)

11547 (CEA-R–3872) CONTRIBUTION TO THE STUDY OF THE REACTIVITY OF RECOIL SPECIES IN POTASSIUM FERROCYANIDE IRRADIATED BY THERMAL NEUTRONS. Meriadec Vernier de Byans, Brigitte (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). May 1969. 104p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Univ. of Paris, France.

The chemical species produced by potassium ferrocyanide neutron irradiation were separated and identified. The study of their behavior upon thermal annealing has allowed the establishment of a schema of reaction as well as a kinetic treatment of the data. Activation energies are determined in different conditions and the effects of radiation dose, oxygen, and water of crystallization upon the activation energies were studied. Preliminary ESR data and its relevance of the decomposition process is also discussed. (auth)

11548 (IA–1190) RESEARCH LABORATORIES ANNUAL REPORT, JANUARY–DECEMBER 1968. (Israel Atomic Energy Commission, Tel Aviv). July 1969. 309p. Dep. CFSTI (U. S. Sales Only).

Brief summaries are presented of the research work in various nuclear energy fields conducted during 1968 by the Israel Atomic Energy Commission. A separate abstract was prepared for each of 12 sections. (H.D.R.)

For abstracts of individual sections see: 11505, 11506, 11549, 11550, 11693, 11733, 11858, 11928, 12337, 12890, 13312, and 13576.

11549 (IA–1190, pp 93–122) NUCLEAR CHEMISTRY. (Israel Atomic Energy Commission, Tel Aviv).

A review is presented on research on fission and high energy chemical reactions, nuclear methods of analysis (activation analysis, X-ray fluorescence, etc.), development and production of radioactive sources and substances, and Hot Laboratory operations, including radiography. During 1968 the SOLIS (Soreq On-Line Isotope Separator) for studying short-lived fission products was assembled near beam tube No. 1 at the IRR-1 reactor, and operation was begun. Design and construction of an accelerator for ions, atoms, and molecules for studying and the mechanism of chemical reactions at high kinetic energies (>10 eV) was initiated in order to complement current hot atom chemistry studies. The apparatus will consist of two major parts in tandem—an electromagnetic mass spectrometer for accelerations and isotopic dispersion, and a quadrupole mass spectrometer for analysis of the reaction products. (auth)

11550 (IA–1190, pp 123–31) RADIATION CHEMISTRY. (Israel Atomic Energy Commission, Tel Aviv).

Research on electron transfer reactions in gamma irradiated solutions, with stress on the fate of the solute anions, was continued. The kinetics of radioinduced chain reactions was analyzed, and the photolytic isotopic exchange between iodine and iodoarmatic compounds was studied. (auth)

11551 (JAERI–5022) ANNUAL REPORT NO. 2 OF OSAKA LABORATORY FOR RADIATION CHEMISTRY (APRIL 1, 1968–MARCH 31, 1969). (Japan Atomic Energy Research Inst., Osaka. Osaka Lab.). Oct 1969. 198p. (In Japanese and English). Dep. CFSTI (U. S. Sales Only).

Thirty-six articles are included; separate abstracts were prepared for 31. The remaining five are abstracts of papers on: spectral study of radioinduced thermoluminescence; proton hyperfine coupling in the methyl-substituted phenyl radicals; radioinduced polymerization of pentoxane; chemical structure of poly-(vinyl alcohol)–methyl methacrylate graft copolymers prepared by various methods; and protective effect of graft copolymer on precipitation of homopolymer. (P.C.H.)

For abstracts of individual papers see: 11552–11582.

11552 (JAERI–5022, pp 1–5) FORMATION OF DIMER CATIONS OF TOLUENE AND p-XYLENE IN THE ADSORBED STATES. Nagai, Siro; Ohnishi, Shun-ichi; Nitta, Isamu (Japan Atomic Energy Research Inst., Osaka. Osaka Lab.). (In Japanese).

Free radicals from γ-irradiated methylbenzene–silica gel systems were investigated by ESR from the standpoint of the extension of the study in benzene–silica gel system. Changes of ESR spectra with the amount of adsorbates were studied in detail. ESR spectra observed from toluene–silica gel and p-xylene–silica gel systems showed the formation of the respective monomer and dimer cation radicals. On the other hand, evidence of dimer cation formation was not obtained in o-xylene, m-xylene, and mesitylene on silica gel. Isotherms of the benzene–silica gel system showed an anomalous behavior in the low pressure region, and this anomaly suggests that the dimer molecule may be formed in the adsorbed state before irradiation. (auth)

11553 (JAERI–5022, pp 6–12) ESR STUDY OF γ-IRRADIATED NH_3–SILICA GEL SYSTEM. Nagai, Siro; Ohnishi, Shun-ichi; Nitta, Isamu (Japan Atomic Energy Research Inst., Osaka. Osaka Lab.). (In Japanese).

The ammonia–silica gel system was γ irradiated at –196°C. ESR spectrum observed from this system exhibited anomalous line widths among the hf lines. This spectrum was assigned to the NH_2 radicals which rotate slowly about the axis perpendicular to the radical planes. A qualitative explanation of the anomalous line widths was made using the model mentioned above. The rotational effects on the ESR spectra of NH_2 radicals in the matrices of water and ammonia are also discussed. (auth)

11554 (JAERI–5022, pp 13–17) EFFECTS OF IRRADIATION ON PLATINUM–OXYGEN ELECTRODE. Hirota, Kozo; Hatada, Motoyoshi (Japan Atomic Energy Research Inst., Osaka. Osaka Lab.). (In Japanese).

Preliminary studies were made on the effects of irradiation on the potential vs polarizing current curve for platinum–oxygen electrodes in aqueous potassium hydroxide solutions. Polarization of the oxygen electrode irradiated with electron beams from a Van de Graaff accelerator was found to decrease to one seventh of that of the unirradiated at the polarization current of 2.6 mA. Similar experiments were also carried out under intermittent irradiations and the component which responded to the pulsed irradiation was observed up to the frequency of 1,000 c/sec. The effects observed may be explained partly by the rise of local temperature at the electrode surface and partly by intermediates produced during irradiation. (auth)

11555 (JAERI–5022, pp 18–26) SPECTROSCOPIC STUDIES ON RADIATION-INDUCED POLYMERIZATION. III. ABSORP-

TION SPECTRA OF IRRADIATED ISOBUTENE AND IT POLYMERIZATION IN LOW TEMPERATURE ORGANIC GLASSES. Kamiyama, Hideo; Hayashi, Koichiro; Okamura, Seizo (Japan Atomic Energy Research Inst., Osaka. Osaka Lab.). (In Japanese).

Absorption bands in the range of 220 to 2000 mμ and liquid nitrogen temperature were observed with γ-irradiated isobutene in glassy solvents. An intensity decrease of the 6128 cm^{-1} band characteristic of the irradiated monomer was also measured. In glassy saturated hydrocarbons such as isopentane and 3-methylhexane, cationic polymerization propagated even at 77°K, and a very broad band appeared near 290 mμ, which was assigned to the propagating species—tert-butyl carbonium cation. In the glassy polar solvent, n-butyl chloride, the polymerization was initiated only after warming up, and a band which appeared at 660 mμ was regarded to be a precursor of initiating species. (auth)

11556 (JAERI–5022, pp 27-32) SPECTROSCOPIC STUDIES ON RADIATION-INDUCED POLYMERIZATION. IV. ABSORPTION SPECTRA OF IRRADIATED ACRYLONITRILE AT THE LOW TEMPERATURE GLASSY STATE. Takagi, Teiitsu; Kamiyama, Hideo; Hayashi, Koichiro; Okamura, Seizo (Japan Atomic Energy Research Inst., Osaka. Osaka Lab.). (In Japanese).

Active species and the reaction mechanism of γ-radioinduced copolymerization of acrylonitrile and propylene in the presence of zinc chloride were studied by means of electronic absorption spectra in organic glass. As glass solutions, a system of ethanol, which was used as the solvent of copolymerization, and a rigorously dried system of 2-methyl-tetrahydrofuran were treated. α-Propionitrile radical in the former and acrylonitrile anion radical in the latter were observed, respectively. In the presence of zinc chloride, an active species was observed near 320 mμ in both systems and tentatively assigned to monovalent Zn cation, which was formed by electron capture from Zn^{2+}. (auth)

11557 (JAERI–5022, pp 33-6) RADIATION-INDUCED COPOLYMERIZATION OF STYRENE AND ACRYLONITRILE IN EMULSION SYSTEM. Kamiyama, Hideo; Okamura, Seizo (Japan Atomic Energy Research Inst., Osaka. Osaka Lab.). (In Japanese).

The radioinduced polymerization of styrene and acrylonitrile in an emulsion system was studied using different kinds of detergents. When nonionic detergent was used, maximum rate of conversion was observed near equimolar composition of monomer mixture. This irregular behavior is discussed in relation to the radiation effect on initiation mechanism of the copolymerization. (auth)

11558 (JAERI–5022, pp 37-44) RADIATION-INDUCED POLYMERIZATION IN EMULSION SYSTEM USING CATIONIC SURFACTANT. I. CHARACTERISTIC PROPERTIES OF PRODUCED POLYMER EMULSION. Ohdan, Koji; Okamura, Seizo (Japan Atomic Energy Research Inst., Osaka. Osaka Lab.). (In Japanese).

Vinyl acetate and methyl acrylate were polymerized in an aqueous system with a cationic surfactant by γ-irradiation, and resultant emulsions were compared to the emulsions prepared by the conventional method, namely, polymerization by adding radical polymerization initiators or emulsification by anionic or nonionic surfactant. As a result, some properties, such as heat stability and stability to coalescence by electrolytes, were found to be superior to the latter. The cationic methyl acrylate–N-methylol acrylamide copolymer emulsion was deposited electrophoretically on the cathode surface. (auth)

11559 (JAERI–5022, pp 45-9) RADIATION-INDUCED COPOLYMERIZATION OF OLEFINS IN THE PRESENCE OF METAL SALTS. Hayashi, Kanae; Hayashi, Koichiro (Japan Atomic Energy Research Inst., Osaka. Osaka Lab.).

The radioinduced copolymerization of olefins with vinyl monomers was carried out in the presence of equimolar concentrations of metal salts in ethanol solution. In the cases of ethylene–acrylonitrile and propylene–acrylonitrile, the addition of $ZnCl_2$ increased the rate of polymerization and gave a copolymer of higher olefin content. However, in the cases of propylene–vinyl chloride and propylene–methyl methacrylate, $ZnCl_2$ showed no significance in copolymer composition, though an increase in the polymerization rate was observed in the former case. The effects of polymerization temperature, solvents, and the other metal salts on copolymerization were also studied. (auth)

11560 (JAERI–5022, pp 50-2) RADIATION- AND PHOTO-INDUCED COPOLYMERIZATION OF ARCYLONITRILE AND PROPYLENE IN THE PRESENCE OF METAL SALTS. Takagi, Teiitsu; Kamiyma, Hideo; Hayashi, Koichiro (Japan Atomic Energy Research Inst., Osaka. Osaka Lab.). (In Japanese).

Gamma radioinduced copolymerization of acrylonitrile and propylene was studied in the presence of various kinds of metal salts. It was found that, even in the absence of metal salts, the copolymerization propagated considerably, and some metal salts, such as zinc chloride, showed a positive effect on the rate of polymerization and copolymer composition. In order to compare with γ rays, ultraviolet irradiation was also studied. Marked differences in the monomer composition of copolymers were not observed. (auth)

11561 (JAERI–5022, pp 53-8) RADIATION-INDUCED COPOLYMERIZATION OF FORMALDEHYDE IN LIQUID CARBON DIOXIDE. Toriuchi, Yahiko; Hayashi, Koichiro; Okamura, Seizo (Japan Atomic Energy Research Inst., Osaka. Osaka Lab.). (In Japanese).

The radioinduced copolymerization of formaldehyde with various vinyl monomers and cyclic ethers in carbon dioxide at 0°C was studied. Styrene, α–methylstyrene, isobutene, vinyl ethers, and styrene oxide were able to copolymerize with formaldehyde. It was concluded that polymerization in this system was proceeded by cationic mechanism. The copolymerization product was partly contained formaldehyde homopolymer, but the main part was a thermally stable copolymer. The ratio of thermally stable copolymer to formaldehyde homopolymer increased with the comonomer content in monomer mixture and polymerization time. (auth)

11562 (JAERI–5022, pp 59-65) EFFECT OF OXYGEN AND WATER ON THE PRE-IRRADIATION GRAFTING TO CELLULOSE. Okada, Toshio; Kohdera, Kanako; Sakurada, Ichiro (Japan Atomic Energy Research Inst., Osaka. Osaka Lab.). (In Japanese).

The effects of the presence of oxygen and water on the preirradiation grafting to cellulose were studied. Grafting of styrene to cellulose fibers of polynosics, regular rayon, and cotton irradiated in different conditions with γ rays was carried out at 50°C. When the fibers were irradiated in the dry state, the presence of oxygen during irradiation had a small effect on the degree of grafting. The presence of adsorbed water in the fibers during irradiation decreased the degree of grafting greatly, especially for polynosics and regular rayon. Similar behavior was observed for grafting at 80 and 117°C and the extent of grafting decreased with increasing temperature of the grafting. ESR measurements of free radicals were also made for the cellulose fibers irradiated under different conditions. In case of irradiation of dry samples, oxygen had no obvious effect on the amount and nature of the radicals. The presence of water during irradiation decreased the formation of radicals markedly and modified the hyperfine structure. From these results it was concluded that the grafting to cellulose fibers is initiated not by peroxides but by trapped radicals independent of the presence or absence of oxygen during preirradiation. (auth)

11563 (JAERI–5022, pp 66-73) GRAFTING OF ACRYLONITRILE ONTO POLYVINYL CHLORIDE FIBER. Sakurada, Ichiro; Hosono, Masao; Okada, Toshio (Japan Atomic Energy Research Inst., Osaka. Osaka Lab.).

Grafting of acrylonitrile onto undrawn poly(vinyl chloride) fibers was carried out using simultaneous irradiation and catalytic methods. Drawing of the grafted fibers was also studied to give fibers of sufficiently high tensile strength and heat resistance. The radiation method was found to be preferable to the catalytic one because of the following reasons: Graft yield, especially when percent graft greater than 50% is concerned, was higher in the case of the radioinduced grafting than the catalytic one. Under every condition of drawing, grafted fibers by radiation could be drawn more smoothly than catalytically grafted ones. When the degree of grafting and drawing of the grafted fiber by radiation was the same as that prepared by catalytic method, the former showed better tensile properties. Grafted fiber by catalytic method was generally milky and turbid whereas that by the radiation method was transparent. The above mentioned differences between the two methods may be attributed to the difference in temperature of grafting; the radioinduced grafting was carried out at room temperature whereas the catalytic grafting had to be carried out at higher temperature (60°C). (auth)

11564 (JAERI–5022, pp 74-8) RADIATION INDUCED GRAFT COPOLYMERIZATION TO POLYESTER. III. GRAFTING OF ACRYLIC ACID TO DRAWN POLYETHYLENE TEREPHTHALATE FIBER WITH IMPREGNATION METHOD. Okada, Toshio; Sakurada, Ichiro (Japan Atomic Energy Research Inst., Osaka. Osaka Lab.). (In Japanese).

Drawn polyethylene terephthalate (PET) fibers were impregnated with acrylic acid or its solution in organic solvents, particularly in ligroine and then subjected to γ rays from ^{60}Co in nitrogen atmosphere at doses up to complete polymerization of impregnated monomer. When the samples were irradiated at room temperature, most of the polyacrylic acid formed was extracted

from the fiber with water at 100°C whereas with irradiation at temperatures above 100°C almost all polymer formed by the irradiation could not be extracted. This indicates that nearly all of the impregnated acrylic acid can apparently graft-copolymerize to the fiber with irradiation at or above 100°C. By this technique, graft PET fibers up to 30% graft can be prepared with good openability, that is without mutual adhering of fibers. (auth)

11565 (JAERI–5022, pp 79-83) STAIN RELEASE TREATMENT OF POLYESTER FABRICS BY RADIATION-INDUCED GRAFTING. Urakami, Motoaki; Okada, Toshio (Japan Atomic Energy Research Inst., Osaka. Osaka Lab.). (In Japanese).

The grafting of acrylic acid to polyester fabrics was studied using the impregnation method. The fabrics impregnated with acrylic acid solution were irradiated in air at room temperature with 1.5-MeV electrons from a Van de Graaff accelerator. Under such conditions the product showed less than 10% graft. Repeating of impregnation-irradiation steps was useful to obtain fabrics of higher percent graft. Resulting graft fabrics were hydrophylic and had soil release ability. Alkali pretreatment of fabrics prior to the grafting was found to be effective for obtaining grafts with good stain-release properties. The effects of irradiation temperature, solvent, and atmosphere on the grafting to fabrics were also investigated by the immersion method using γ rays. It was found that the grafting took place very smoothly when the fabrics were immersed in a mixture of acrylic acid and nonswelling agent such as ligroine and kerosene followed by irradiation with γ rays in the temperature range of 80 to 150°C. (auth)

11566 (JAERI–5022, pp 84-8) VISCOELASTIC BEHAVIOR OF POLY(VINYL ALCOHOL)–METHYL METHACRYLATE GRAFT COPOLYMER. Suzuki, Yasuo; Okada, Toshio (Japan Atomic Energy Research Inst., Osaka. Osaka Lab.). (In Japanese).

Poly(vinyl alcohol) (PVA)–methyl methacrylate (MMA) graft copolymer was prepared by a preirradiation technique. Studies were made on the graft copolymer with one branch whose chain length was nearly the same as that of the backbone polymer. For comparison the studies were also carried out on the conventional graft copolymer which is considered as the mixture of true graft copolymers, PVA and PMMA. The viscoelastic properties of the true graft copolymer were observed to be similar to that of the conventional one over the temperature range of 20 to 170°C. Dynamic loss tangent-temperature curves for the two kinds of graft copolymers showed the existence of two transitions. The one that appeared in the lower temperature region of about 60°C corresponded to the glass transition region of the PVA part in the graft copolymer. This transition temperature in the graft copolymer was lower than that of pure PVA. In the higher temperature range a sharp peak appeared at 145°C for both graft copolymers. This sharp peak may be attributed to transition of PMMA polymerized within crystalline PVA. Probably the PMMA segments in the neighborhood of PVA crystalline regions were under sufficient stress to increase their transition temperature. (auth)

11567 (JAERI–5022, pp 89-93) VISCOELASTIC BEHAVIOR OF POLY(ETHYLENE TEREPHTHALATE)–STYRENE GRAFT COPOLYMER. Suzuki, Yasuo; Okada, Toshio (Japan Atomic Energy Research Inst., Osaka. Osaka Lab.). (In Japanese).

The viscoelastic properties of the graft copolymers of styrene with amorphous poly(ethylene terephthalate) (PET) fiber prepared by mutual irradiation were studied. The effects of heat treatment after grafting on the viscoelastic properties were also studied. The samples used were conventional graft copolymers which were composed of true graft copolymer, ungrafted PET, and polystyrene It was found that the small amount of solvent that remained in the graft copolymer markedly affected its viscoelastic behavior. The loss tangent-temperature curves indicated two glass transitions, one at 100 to 105°C corresponding to the transition temperature of amorphous PET phase and the other at 107 to 110°C corresponding to the polystyrene phase. This indicates that the graft copolymer consists of two separate phases of the component polymers, amorphous PET and polystyrene. (auth)

11568 (JAERI–5022, pp 94-7) VISCOELASTIC BEHAVIOR OF POLY(ETHYLENE TEREPHTHALATE)-4-VINYL PYRIDINE GRAFT COPOLYMER. Suzuki, Yasuo; Okada, Toshio (Japan Atomic Energy Research Inst., Osaka. Osaka Lab.). (In Japanese).

Poly(ethylene terephthalate)–4-vinylpyridine (PET–4-VP) fiber was prepared by a mutual irradiation method. Amorphous PET fibers, which were used as the starting fibers, were subjected to γ rays while immersed in aqueous emulsion of 4-VP. The samples used were conventional graft fibers composed of true graft copolymer, ungrafted PET, and 4-VP polymer. Viscoelastic measurements were carried out over the temperature range of 20 to 200°C. Glass transition temperature of 4-VP polymer was determined to be 151 to 156°C from dynamic loss tangent-temperature curve. PET–4-VP graft fiber showed a single broad transition which lay between the transitions of two component polymers. The transition temperature of the graft copolymer increased with increase in degree of grafting. It was concluded that the component polymers are more or less molecularly mixed in the graft fiber. (auth)

11569 (JAERI–5022, pp 98-102) COMPARISON OF RADIATION- AND CONVENTIONAL CATALYTICALLY-INDUCED POLY(VINYL CHLORIDE)-ACRYLONITRILE GRAFT FIBERS AT VISCOELASTIC BEHAVIOR. Suzuki, Yasuo; Okada, Toshio (Japan Atomic Energy Research Inst., Osaka. Osaka Lab.). (In Japanese).

As has been reported, radioinduced poly(vinyl chloride)–acrylonitrile (PVC–AN) fibers have advantages of high drawing ability and excellent transparency over catalytically grafted ones. In order to investigate the differences in these properties for the two types of graft fibers, studies of viscoelastic properties were carried out. Dynamic viscoelastic properties–temperature curves for PVC–AN fibers showed the existence of two transition temperatures, which correspond to the glass transition temperatures of PVC and PAN phases, respectively. Transition temperatures of radioinduced graft fibers were practically independent of the degree of grafting whereas catalytically produced ones shifted towards higher temperatures as the degree of grafting increased. The shapes of dynamic loss tangent–temperature curves showed that the amount of phase mixing is larger in the radioinduced grafted fibers than in the catalytically grafted ones. The differences in properties between the two types of graft fibers may be at least partly attributed to the difference in the degree of mixing of the two-component polymer phases. (auth)

11570 (JAERI–5022, pp 103-10) RADIATION CURING OF MIXTURE OF DIALLYLPHTHALATE PREPOLYMER AND VINYL MONOMER. I. EXAMINATION OF FUNDAMENTAL CONDITIONS FOR RADIATION CURING OF MIXTURE OF DIALLYLPHTHALATE PREPOLYMER AND VINYL MONOMER. Gotoda, Masao; Tsuji, Tadashi; Manabe, Akiyoshi; Takeuchi, Tamotsu; Azato, Ikuo (Japan Atomic Energy Research Inst., Osaka. Osaka Lab.). (In Japanese).

A new method has been found for the radiation (especially electron beam) curing of diallyl phthalate (DAP) resin. The method consists of mixing a suitable monomer (and polyfunctional crosslinking monomer) and peroxide catalyst with diallyl phthalate prepolymer (DAPp) and irradiation after fabrication. Studies made on the suitable composition and ratio of methacrylic acid, vinyl acetate (VAc), acrylonitrile, and benzoyl peroxide for mixing with DAPp are reported. ^{60}Co γ radiation and electron beam curing processes were compared for the DAPp–VAc system. A post curing effect was also examined. It was found that curing does not proceed further after leaving the irradiated system for some time, but occurs by heating at 60 to 80°C for a short time, presumably because of the thermal (and catalytic) polymerization of VAc and subsequent crosslinking by it. (P.C.H.)

11571 (JAERI–5022, pp 111-24) RADIATION CURING OF MIXTURES OF DIALLY PHTHALATE PREPOLYMER AND MONOMER. II. STUDIES OF ELECTRON BEAM CURING OF MIXTURES OF DIALLYL PHTHALATE PREPOLYMER AND MULTI COMPONENT MONOMERS, AND ITS APPLICATION TO DECORATIVE LAMINATE FOR WOOD VENEER. Gotoda, Masao; Yokoyama, Kenji; Kodama, Takashi; Kohno, Yoshimi (Japan Atomic Energy Research Inst., Osaka. Osaka Lab.). (In Japanese).

Studies were made on the electron beam radiation curing of mixtures of diallyl phthalate with multicomponent monomers in the presence of benzoyl peroxide (BPO). The mixtures studied included diallyl phthalate (DAP) and (BPO) and one or more of the following: methacrylic acid (MA), vinyl acetate (VAc), acrylonitrile (AN), methyl methacrylate (MMA), allyl acrylate (AA), and butyl acrylate (BA). As a multicomponent monomer, VAc–MA (3/1) was found to be very effective for curing. For the system DAP–VAc–MA–AA–BPO (60/30/10/4/4), the conversion exceeded 90% by electron beam irradiation, and nearly perfect conversion was attained by subsequent suitable short post-curing. These radiation cured systems were found to have excellent properties for practical use as decorative laminate for wood veneer. (P.C.H.)

11572 (JAERI–5022, pp 125-34) PREPARATION OF WOOD-POLYMER COMPOSITE BY IONIZING RADIATION. I. RADIATION-INDUCED POLYMERIZATION OF VINYLIDENE CHLORIDE IMPREGNATED IN WOOD. Gotoda, Masao; Tsuji, Tadashi; Tsubomoto, Kazuo; Hagito, Yasuhiko (Japan Atomic Energy Research Inst., Osaka. Osaka Lab.).

Studies were made on the radioinduced polymerization of vinylidene chloride (VDC) in wood and the properties of the wood–polymer composites (WPC) for the purpose of improving the inflammability and dimensional stability of wood. Among the

homegrown woods checked for this purpose, beech was found to be most suitable. Gamma- and electron-beam induced polymerization of VDC in beech was tried, with special reference to presoaked moisture in wood. Conversion of VDC by electron-beam irradiation was very low, whereas that by γ irradiation was very high and the required irradiation dose was also very small. Bulking effect produced by polymerization of VDC in wood, was found to be very small in the case of γ irradiation but became pronounced in the case of electron-beam irradiation, especially for wood with much moisture. Improvement in the hygroscopic properties of beech–poly(vinylidene chloride) (PVDC) composite was correlated with these phenomena, and improvement of hygroscopic properties was larger by electron-beam irradiation than by γ irradiation. Thus, dimensional stability was improved by only small polymer loading in the case of electron-beam irradiation of wood with much moisture. (auth)

11573 (JAERI–5022, pp 135-43) PREPARATION OF WOOD-POLYMER COMPOSITE BY IONIZING RADIATION. II. GAMMA RAY INDUCED COPOLYMERIZATION OF VINYLIDENE CHLORIDE AND METHYL METHACRYLATE AND/OR ACRYLIC ACID IN BEECH. Gotoda, Masao; Tsuji, Tadashi; Tsubomoto, Kazuo (Japan Atomic Energy Research Inst., Osaka. Osaka Lab.).

Studies were made on the γ-induced polymerization of vinylidene chloride (VDC) and methyl methacrylate and/or acrylic acid (AA) in beech. For the purpose of obtaining a continuous polymer and also to allow intimate contact with the cell wall inside the wood by swelling, methyl methacrylate and/or acrylic acid were chosen as a comonomer of vinylidene chloride, and γ-induced polymerization of these comonomers in beech and also the hygroscopic properties of WPC thus obtained were examined with special reference to the effects of water, either presoaked in wood or added in these impregnants. As a result, acrylic acid was found to accelerate the polymerization of vinylidene chloride in wood, whereas methyl methacrylate had the reverse effect. The addition of small amounts of water did not affect the polymerization rate. By choosing the proper composition of these comonomers (especially in the case of VDC and AA), the dimensional stability of wood was improved and small amounts of water added had a pronounced effect on the properties (while it did not affect the polymerization rate). It was necessary to minimize the addition of acrylic acid to vinylidene chloride in order to prevent swelling of WPC under humid conditions, and also to study the effects of water added to monomers or presoaked in wood on the hygroscopic properties of WPC. (auth)

11574 (JAERI–5022, pp 144-56) PREPARATION OF WOOD-POLYMER COMPOSITE BY IONIZING RADIATION. III. GAMMA RAY INDUCED POLYMERIZATION OF VINYLIDENE CHLORIDE AND METHYL METHACRYLATE WITH POLYETHYLENEGLYCOL IN BEECH. Gotoda, Masao; Tsuji, Tadashi; Hagito, Yasuhiko (Japan Atomic Energy Research Inst., Osaka. Osaka Lab.).

Poly(ethylene glycol) was mixed with vinylidene chloride and methyl methacrylate, and polymerized in beech by γ irradiation. By adding poly(ethylene glycol), γ-induced polymerization in beech was accelerated, but to promote the bulking and dimensional stabilization of wood, the presence of water was found to be necessary. Also, water added to these impregnants was not effective, but the water presoaked in wood had a pronounced effect. Also, the effects of molecular weight of poly(ethylene glycol) must be studied further, as poly(ethylene glycol) 600 mainly used caused WPC to have a damp feeling, especially in a humid environment. (P.C.H.)

11575 (JAERI–5022, pp 165-8) STUDY OF THE ENERGY LOSS FUNCTION OF ELECTRONS BY VACUUM ULTRAVIOLET TECHNIQUE. I. EXPERIMENTAL APPARATUS AND REFLECTANCE OF POLYSTYRENE. Nakai, Yohta; Matsuda, Koji; Takagaki, Torao; Kimura, Ki-ichi (Japan Atomic Energy Research Inst., Osaka. Osaka Lab.). (In Japanese).

In order to understand the interaction of low-energy electrons with solid polymers, a series of studies to determine the optical properties of such material in the vacuum ultraviolet region (1000 to 3000 Å) has been started. The first step involves the construction of apparatus, preparation of samples, and the reflectance measurements of polystyrene as a typical polymer. The energy-loss peak at 6.3 eV in polystyrene is discussed. (auth)

11576 (JAERI–5022, pp 169-74) TUNNELING OF LOW ENERGY ELECTRON AND ELECTRIC PROPERTIES OF METAL-THIN POLYMER–METAL SYSTEM. I. PREPARATION OF SEVERAL KINDS OF EXTREMELY THIN POLYMER AND THEIR ELECTRIC PROPERTIES. Takagaki, Torao; Nakai, Yohta; Matsuda, Koji; Kimura, Ki-ichi (Japan Atomic Energy Research Inst., Osaka. Osaka Lab.). (In Japanese).

Studies were made on a method for the formation of extremely thin polymer films (~10^2 Å) on metal film substrates. The essential purpose is to better understand the behavior of low energy electrons in polymers and the use to new electronic devices in studies of this kind. The results showed that the glow discharge method is acceptable for making thin, uniform, and no pinhole polymer films, and that the voltage-current characteristics of these films are nonohmic. Preliminary measurements on the photoelectric effect of metal–polymer–metal systems in the vacuum ultraviolet region showed interesting behavior. (auth)

11577 (JAERI–5022, pp 175-9) RADIATION EFFECTS ON SOME METAL ACETYLACETONATES (PRELIMINARY REPORT). Hatada, Motoyoshi; Nagai, Siro; Ohnishi, Shun-ichi; Nitta, Isamu (Japan Atomic Energy Research Inst., Osaka. Osaka Lab.). (In Japanese).

Radiation effects on the five metal acetylacetonates: $Be(acac)_2$, $Mg(acac)_2$, $Al(acac)_3$, $Zn(acac)_2$, and $Zr(acac)_4$ were studied by ESR. The spectra of the irradiated acetylacetonates except that of $Be(acac)_2$ were similar to one another, but they differed slightly in shape according to their metal ions. The spectrum of the irradiated $Be(acac)_2$ was regarded as a double-septet at −196°C and changed its shape significantly with increasing temperature. The preliminary results of the ESR study of the acetylacetonates and the results of the analysis of the thermoluminescent curve of irradiated $Be(acac)_2$ are reported. (auth)

11578 (JAERI–5022, pp 180-4) RADIOLYSIS OF METHYL ETHYL ETHER. Takezaki, Jun'ichi; Hirota, Kozo (Japan Atomic Energy Research Inst., Osaka. Osaka Lab.). (In Japanese).

Primary products from the radiolysis of ethyl methyl ether in the gaseous phase and their G-values were: H_2 4.7; CO 0.51; CH_4 0.25; and C_2H_4 0.18. The radiolysis of deuterated ethers was investigated and the formations of hydrogen and methane are discussed. (auth)

11579 (JAERI–5022, pp 185-9) IRRADIATION EFFECTS OF GRAMICIDIN. Sugimoto, Shun-ichi; Ohnishi, Shun-ichi; Nitta, Isamu (Japan Atomic Energy Research Inst., Osaka. Osaka Lab.). (In Japanese).

Gamma radiation effects on gramicidin and the effects of γ-irradiated gramicidin on amino acids have been studied by ESR, amino acid analyses, column chromatographs on Sephadex, and biological activity tests. The main ESR component observed at room temperature consisted of nine lines (splitting 6 Gauss). The free radical responsible for this nonet can be assigned to phenylalanine radical. Radical accumulation curves were measured at room temperature and −196°C. Initial formation G_R values of irradiated samples were about unity at both temperatures. Amino acid analyses showed that proline residue was the most radiation resistant amino acid. When irradiated in vacuum in the polycrystalline state, phenylalanine residue was radiation resistant. On the other hand, when irradiated in air or in solution of methyl alcohol–water (2 : 3), the phenylalanine residue decreased remarkably. (auth)

11580 (JAERI–5022, pp 190-3) RADIATION-INDUCED POLYMERIZATION OF ADSORBED MONOMERS. I. VINYL MONOMERS ON SILICA GEL. Shimizu, Akira; Hayashi, Koichiro; Okamura, Seizo (Japan Atomic Energy Research Inst., Osaka. Osaka Lab.). (In Japanese).

The radioinduced polymerization of vinyl monomers adsorbed on silica gel was studied. The monomers included butadiene, methyl methacrylate, acrylonitrile, and styrene. Polymerizations of these monomers adsorbed on silica gel in a monolayer concentration showed a great polymerization rate enhanced by an energy transfer from silica gel to the adsorbed monomers. A difference in an adsorbed state polymerization from an ordinary bulk polymerization was also observed in a different dose rate dependency of the polymerization rate, that is $R_p \propto I^{0.8}$, in the case of methyl methacrylate polymerization. Polymers prepared in an adsorbed state did not show any characteristic structure by ir and NMR spectra. The reactivity ratios in the polymerization of acrylonitrile and methyl methacrylate were no different from those of a bulk copolymerization. Polymerization mechanism of methyl methacrylate in a silica gel was studied by ESR spectroscopy and the propagating radical was observed. (auth)

11581 (JAERI–5022, pp 194-5) STUDIES ON RADIATION-INDUCED FREE IONIC POLYMERIZATION BY ELECTRICAL CONDUCTIVITY MEASUREMENTS. I. ISOBUTYL VINYL ETHER (PRELIMINARY REPORT). Hayashi, Kanae; Hayashi, Koichiro; Okamura, Seizo (Japan Atomic Energy Research Inst., Osaka. Osaka Lab.). (In Japanese).

The radioinduced polymerization of isobutyl vinyl ether was carried out during the simultaneous measurement of electric conductivity. In a superdried sample where a half-power dependence of the rate of polymerization on dose rate was achieved,

the specific conductance was decreased to half of that in the non-dried one. The rate constant for free ionic propagation was estimated to be $(1.1 \pm 0.4) \times 10^5$ M^{-1} sec^{-1} assuming G(initiation) = 0.15 ± 0.05 at 25°C. (auth)

11582 (JAERI-5022, pp 196-8) STUDY ON THE REACTIONS OF THE ACTIVE SPECIES IN IRRADIATED ORGANIC SOLIDS BY DIFFERENTIAL THERMAL ANALYSIS. Nishii, Masanobu; Hayashi, Koichiro; Okamura, Seizo (Japan Atomic Energy Research Inst., Osaka, Osaka Lab.). (In Japanese).

A decay process of the active species trapped in γ-irradiated organic solids has been studied by differential thermal analysis. For this purpose, an apparatus for low-temperature differential thermal analysis was constructed. The apparatus permits analysis over the temperature range −205 to +120°C. From differential thermal analysis curves of the crystalline methanol γ irradiated at −196°C, an exothermic peak was found in the temperature range from −131 to −116°C. This exothermic peak showed that trapped active species disappeared in this temperature range which was lower than the phase transition point (−114°C) of methanol. In the case of γ-irradiated acrylic acid, an exothermic peak of the decay process of trapped active species was not observed, but it was found that the post-polymerization proceeded in a low temperature region which was lower than the reported polymerizable temperature region. (auth)

11583 (ORNL-TM-2772) THERMAL REACTIONS OF IODINE WITH OLEFINS, AND RADIATION-INDUCED REACTIONS WITH PARAFFINS, A BRIEF LITERATURE SURVEY PERTINENT TO LMFBR FUEL PROCESSING. Davis, Wallace Jr. (Oak Ridge National Lab., Tenn.). Dec 1969. Contract W-7405-eng-26. 16p. Dep. CFSTI.

Available data on reactions of iodine with olefins and with free radicals produced by the radiolysis of hydrocarbons are summarized. Very little reaction of iodine with olefinic impurities would be expected at the low iodine ($\ll 10^{-3}$ mole/liter) and olefin concentrations (probably <0.05 mole/liter) assumed to be present in the first cycle of a tributyl phosphate−n-paraffin solution used for LMFBR fuel processing. However, even with oxygen dissolved in the organic solution, extensive to nearly complete reaction of iodine with hydrocarbon free radicals would probably occur at radiation doses much less than the likely normal maximum of 0.5 whr/liter. (227 references.) (auth)

11584 (ORO-3519-6) RADIATION CHEMISTRY OF MONO-SUBSTITUTED AROMATIC COMPOUNDS. Progress Report, January 15, 1969–January 15, 1970. Knight, J. A. Jr. (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). 28 Jan 1970. Contract AT(40-1)-3519. 22p. Dep. CFSTI.

Studies are being made of the radiolysis of nitrobenzene. In the γ radiolysis of nitrobenzene, the carbon-nitrogen bond is the most susceptible to scission followed by the nitrogen-oxygen bond of the nitro group, and the carbon-hydrogen bond is the least susceptible to radiolytic scission. In the γ-radiolysis of aniline, the gases identified to date are hydrogen, $G = 0.11_8$, and ammonia, G = 0.15. Based on G values of products obtained to date, the radiolytic gases, hydrogen and ammonia, are the most important products. The hydrogen yield is about three times as great as the hydrogen yield from γ-irradiated benzene and was not affected by anthracene, naphthalene, or biphenyl at the concentrations tested. The formation of ammonia shows that the carbon-nitrogen bond is susceptible to radiolytic scission. Benzene, G = 0.021, is the only product identified to date which appears before aniline on the gas chromatograms. The phenylenediamines were not definitely detected as radiolytic products. If the phenylenediamines are present, then they constitute minor radiolytic products with G values of less than 0.0001. Data indicated that the phenylation of aniline is not a major process in γ-irradiated aniline. (M.C.G.)

11585 (RISO-M-1202) ELECTRON-BEAM CURING OF SURFACE COATINGS. Progress Report No. 1, May 1–December 31, 1969. Pedersen, W. Batsberg (Nordisk Forskningsinstitut for Maling og Trykfarver, Copenhagen (Denmark)); Singer, K. (Danish Atomic Energy Commission, Risoe. Research Establishment). Jan 1970. 24p. (In Danish). (NIF-TM-1-70). Dep. CFSTI (U. S. Sales Only).

Acrylic prepolymers with different degrees of vinyl unsaturation were prepared by solution copolymerisation of methylmethacrylate, ethyl acrylate, and glycidyl methacrylate followed by a reaction between the epoxy groups and methacrylic acid. Irradiation of mixtures of prepolymers and different vinyl monomers with electrons from a 10-MeV linear revealed that coatings containing styrene as the vinyl monomer require a larger radiation dose to cure than coatings containing methyl methacrylate, n-butyl methacrylate, ethyleneglycol dimethacrylate, or ortho/para-chlorostyrene. Coatings with a suitable application viscosity were cured by an absorbed radiation dose of 4 Mrads. A discussion of differences between the radioinduced copolymerisation (curing) of unsaturated polyester and of acrylic systems is included. (Denmark)

11586 RADIOLYSIS OF METHYLCYCLOHEXANE. II. THE EFFECT OF CUMENE ON HYDROGEN FORMATION FROM γ-IRRADIATED METHYLCYCLOHEXANE. Kimura, Toyoaki; Fueki, Kenji; Kuri, Zen-ichiro (Nagoya Univ., Japan). Bull. Chem. Soc. Jap.; 42: 3088-92(Nov 1969).

The effect of cumene on the hydrogen yields from methylcyclohexane γ-irradiated at 100, 20, −72, −120 and −196°C was investigated. Cumene did not compete with N_2O for capturing electrons in methylcyclohexane and the yield of thermal H atoms in methylcyclohexane, determined by use of ethylene as an H atom scavenger, was smaller than the decrease in hydrogen yield in methylcyclohexane−cumene systems. Therefore, the decrease in hydrogen yield in methylcyclohexane−cumene systems can be ascribed mainly to positive charge transfer from methylcyclohexane to cumene. Further, the evidence of charge transfer from methylcyclohexane to cumene was found by the optical absorption method. The effect of cumene on the hydrogen yield from methylcyclohexane was similar in the temperature range from 100 to −196°C, especially at high cumene concentration. The effect of an electron scavenger at high concentrations was also examined with n-butyl chloride. Although the effect of a positive ion scavenger on the hydrogen yield from methylcyclohexane in the liquid state differs little from that in the glassy state, the effect of electron scavengers on the former differs considerably from that on the latter. (auth)

11587 INVESTIGATIONS OF THE SZILARD-CHALMERS EFFECT IN PHENYL ARSENIC COMPOUNDS. INFLUENCE OF THE IRRADIATION CONDITIONS. PART 4. TETRAPHENYLARSONIUM HYDROGEN CARBONATE AND PENTAPHENYLARSENIC. Grossmann, G. (Technische Univ., Dresden). Isotopenpraxis; 5: 370-5(Sep-Oct 1969). (In German).

Ph_4AsHCO_3 and Ph_5As were irradiated at different neutron fluxes, intensities of gamma radiation, and temperatures in vacuum or in the presence of air. A thermal treatment (annealing) occurs in many cases. The distribution of radioactive arsenic atoms on products with different numbers of phenyl groups per arsenic atom was determined. The following problems are discussed: activity distribution resulting from primary and secondary effects; change of the diffusion-controlled secondary effects using oxygen as a radical scavenger; tertiary processes resulting from thermal annealing; quaternary effects resulting from gamma rays. The sum of primary and secondary retention for Ph_4AsHCO_3 was 0.65 and for Ph_5As 0.2%. According to a simplified model for tetraphenylarsonium compounds, the yields of activity resulting from primary effects are estimated from different numbers of phenyl groups per arsenic atom. (auth)

11588 ACID ANHYDRIDE AS AN ELECTRON SCAVENGER IN THE RADIOLYSIS OF TETRAHYDROFURAN. Matsui, Masao; Imamura, Masashi (Inst. of Physical and Chemical Research, Saitama, Japan). Bull. Chem. Soc. Jap.; 42: 3362-3(Nov 1969).

The effects of maleic, succinic, glutaric, and phthalic anhydrides on the γ radiolysis of tetrahydrofuran (THF) or methyltetrahydrofuran (MTHF) were investigated. Results show that the $G(H_2)$ decreases with an increase in the acid anhydride, eventually reaching an approximately constant value that is practically the same as that observed in the THF−N_2O system. The G(CO) in the THF−maleic anhydride system increases with increasing concentration of the acid anhydrides. Succinic and glutaric anhydrides were shown to behave in much the same way as maleic anhydride, but phthalic anhydride decreased the $G(H_2)$ but gave no additional carbon monoxide. (D.H.M.)

11589 GAMMA-RAY-INDUCED ADDITION OF FORMAMIDE AND ANILINE TO CROTONIC ACID AND ITS ESTER. Itoh, Mitsuomi; Tokuda, Masao; Yokoyama, Yuji; Suzuki, Akira (Hokkaido Univ., Sapporo). Bull. Chem. Soc. Jap.; 42: 3340-2(Nov 1969).

A study of the γ-induced addition of formamide to crotonic acid and its ethyl ester showed that only the corresponding β-adduct was formed. A γ-induced addition of aniline to crotonic acid and its ethyl crotonate was found to give a small amount of 1:1 adduct. In the case of crotonic acid, only the β-adduct was obtained with a large amount of side reaction products; however, in the case of ethyl crotonate, a yield of small amounts of γ- and β-adducts was detected without side reaction products. The results from the γ-induced method were compared with those from a photochemical method. (D.H.M.)

11590 ON THE RADIATION-CHEMICAL DESTRUCTION OF DIALKYL THALLIUM IONS IN AQUEOUS SOLUTIONS. Sarrach, D. (Deutsche Akademie der Wissenschafte, Berlin). Isotopenpraxis; 5: 367-70(Sep-Oct 1969). (In German).

In dilute aqueous solutions dialkylthallium ions were radiolyti-

cally destructed yielding thallous ions and hydrocarbons. With regard to scavenger effects a mechanism is proposed, which forms alkanes by hydrolysis of an intermediate of the polaron reaction, while OH radicals cause hydrogen abstraction followed by formation of an olefin. Rest fragments form Tl^+ and recombine or are oxidized to H_2O_2 and carbonylic compounds by oxygen. (auth)

11591 HIGH TEMPERATURE SZILARD–CHALMERS ANNEALING IN $KBrO_3$. Jack, J.; Waitz, H. (State Univ. of New York, Stony Brook). Inorg. Nucl. Chem. Lett.; 5: 867-8(Nov 1969).

Reference is made to a study of the Szilard–Chalmers annealing of $NaBrO_3$ following the $^{81}Br(n,\gamma)^{82}Br$ reaction at temperatures high enough for slow thermal decomposition to occur (Jack, J. Inorg. Nucl. Chem., 30: 919(1968)). The same technique was applied to $KBrO_3$. "Retention," defined as $(Br^*O_3^-)/(Br^*O_3^- + Br^{*-})$ and called R*, was plotted as a function of time, together with R, defined as $(BrO_3^-)/BrO_3^- + Br^-)$ and representing a measure of undecomposed bromate in the reaction $KBrO_3 \rightarrow KBr + 3/2\ O_2$. The curve for R decreased from unity at a slowly decreasing rate in much the same way as for $NaBrO_3$, while the curve for R* rose very rapidly at first, with a subsequent decrease in the rate of rise. At about R* = 80% dR*/dt changed sign and the R* curve soon joined the decreasing R curve and remained joined for the rest of the rise. At no time did R* exceed R. These results were identical in form to the $NaBrO_3$ case. The merging of R and R* is interpreted as evidence that $Br^*O_3^-$ is formed from the recoil species in the crystal and not merely from the interaction of a Br*-containing species with the water. The Arrhenius plots for parameters associated with both the thermal decomposition and the Szilard–Chalmers annealing showed features again similar in form to the case of $NaBrO_3$. These features are interpreted as evidence that decomposition occurred homogeneously. Introduction of $^{82}Br^-$ into the $KBrO_3$ crystal resulted in an exchange that is in the production of some $^{82}BrO_3^-$, although to a lesser extent than with $NaBrO_3$. (UK)

11592 RADIATION CHEMISTRY OF POLYACRYLAMIDE. III. THE EFFECT OF THE NATURE OF SIDE GROUPS ON THE FORMATION OF PARAMAGNETIC CENTERS. Milinchuk, V. K. Khim. Vys. Energ.; 3: 533-4(1969). (In Russian).

The problem of the radiation yield (G) of paramagnetic centers (PC) created in polymers by ionizing radiation was investigated by studying the effect of the nature and amount of side groups; it was attempted thereby to correlate the energy of excited states and the formation of PC's during the radiolysis of polyacrylamide (PAA). The polymer was hydrolyzed in aqueous solution at room temperature in the presence of KOH within a period of about 48 hours. The degree of substitution of the amide by carboxyl groups was determined by elementary analysis of the polymers containing 21, 30, 41, and 49 carboxyl groups. It was found that the increase of the carboxyl groups results in an increase of the G from 0.9 for pure PAA to 4.0 ± 0.5 for the pure polyacrylic acid. It was concluded from the results that the radiolysis passes through an ionic stage; both ionic and excited states of the macromolecule participate in the reaction. (TTT)

11593 EPR STUDY OF THE EFFECT OF THE ZEOLITE CATION ON THE RADIOLYSIS OF THE ADSORBED PYRIDINE. Sorokin, Yu. A.; Borisov, E. A. Khim. Vys. Energ.; 3: 534-5 (1969). (In Russian).

CsY, NaY and HY type zeolites were used to examine the effect of the cation on the radiolysis of the pyridine molecules adsorbed at room temperature. The samples were irradiated and EPR spectra were taken at 77°K, varying the radiation dose from 0.3 to 30×10^{22} eV/g. It was found that within a wide range of surface coverage, the radiation yield and the concentration of paramagnetic particles depend on the nature of the action and increase with its increasing radius. The findings agreed with earlier data obtained with similarly adsorbed ammonia. The singlet spectra observed upon exposure to more than 2×10^{21} eV/g may be attributed to α-pyridyl radicals; the spectra obtained do not belong to the paramagnetic centers of the irradiated pure zeolites. (TTT)

11594 ROLE OF EXCITED SPECIES $(RCO–NH–CHR_2)^*$ IN THE RADIOLYTIC OXIDATION OF THE PEPTIDE MAIN-CHAIN IN AQUEOUS SYSTEMS. Garrison, Warren M.; Rodgers, Michael A. J. (Univ. of California, Berkeley). Int. J. Radiat. Phys. Chem.; 1: 541-4(Nov 1969).

In the γ-radiolysis of oxygen-free solutions of simple peptides at concentrations above ≈0.1 mol/l the formation of excited species, $RCO–NH–CHR_2^*$, leads to dissociation of the peptide main-chain with formation of amide and fatty acid functions (Advanc Chem. Ser. 1968, 81, 384). Detailed chemical evidence is reported that the species $RCO–NH–CHR_2^*$ reacts quantitatively with oxidizing solutes such as O_2 and Fe III to yield hitherto undetected oxidation products which have the chemical properties of dehydropeptides. (auth) (UK)

11595 METHOD FOR PRODUCING GRAFT-COPOLYMERS WITH 1-PHTHALIMIDO-1,3-BUTADIENE. Murata, Kenichi (to Agency of Industrial Science and Technology). Japanese Patent 1969-17146. 29 Jul 1969. Filed 10 Jun 1966.

Polyethylene films were immersed in a solution of N-1,3-butadienylphthalimide in an organic solvent and irradiated with ionizing radiation (α, β, γ, x, or high-energy neutrons). The resulting graft copolymer had superior qualities of dyeability, adhesion, and chemical resistance. (D.H.M.)

11596 RADIOTHERMOLUMINESCENCE OF POLYETHYLENE AND POLYPROPYLENE. Mozisek, Max (Research Inst. SIGMA, Olomouc, Czech.). Int. J. Appl. Radiat. Isotop.; 21: 11-16(Jan 1970).

The method and the results obtained from measurement of thermoluminescence of branched polyethylene and isotactic polypropylene irradiated by different doses of ionizing radiation are described. In the case of branched polyethylene, thermoluminescence maxima were identified at temperatures corresponding the known transitions T_g and T_γ. The thermoluminescence maximum at the temperature T_g is influenced by the presence of oxygen in examined samples. (auth) (UK)

11597 STRUCTURE OF DIPOLE-TRAPPED ELECTRONS IN GAMMA-IRRADIATED ACETONITRILE-d_3: DEPENDENCE OF ESR SPECTRUM ON CRYSTALLIZATION METHOD. Takeda, K.; Williams, F. (Univ. of Tennessee, Knoxville). Mol. Phys.; 17: 677-9(Dec 1969).

It was previously found that the quintet ESR spectrum was invariably obtained with samples of $CD_3C^{14}N$ prepared by crystallization at 77°K. In the present studies it was found that the spectrum of the trapped electron was changed to triplet after crystallization at higher temperatures, and it was established that the trapped electron interacts with either two or one ^{14}N nuclei, depending on the crystalline state obtained on cooling. This demonstrates that an electron can be trapped in the dipole field of a single polar molecule. The experimental results in support of this conclusion are given. (UK)

11598 UNSTABLE INTERMEDIATES. PART LXVII. ELECTRON SPIN RESONANCE SPECTRUM OF CYCLOHEXADIENYL RADICALS FROM RESORCINOL: THE MECHANISM OF RADIATION DAMAGE. Campbell, D.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., A; 19: 2977-8(1969).

At 77°K, exposure of resorcinol to γ rays gave, primarily, close pairs of phenoxy radicals. On warming to room temperature these radicals were lost, and there was no evidence for the formation of cyclohexadienyl radicals. Exposure to hydrogen atoms at 77°K or room temperature gave low yields of a species having only a broad single-line esr spectrum. In marked contrast, γ rays at room temperature gave cyclohexadienyl radicals in good yield. Use of deuterated material established that the hydrogen atom was initially bonded to carbon rather than oxygen. Hyperfine coupling tensors obtained from single-crystal studies are reported, and a possible explanation of these unusual differences is suggested. (auth) (UK)

11599 THE RELATIVE ROLE OF ADSORPTION CENTERS WITH VARYING TIMES OF LIFE IN RADIATION CHEMOSORPTION AND THE γ-ADSORPTION EFFECT. Kolbanovskii, Yu. A.; Masterova, M. N.; Polak, L. S. (Inst. of Petrochemical Synthesis, Moscow). Khim. Vys. Energ., 3: 467-9(1969). (In Russian).

Radiation chemosorption is defined as the process due to the action of radiation on the adsorbent–adsorbate system while the γ adsorption effect arises when the adsorbent is irradiated in vacuum. In this connection, the short-lived active centers are radiation-generated; their radiation annealing rate is higher than the thermal annealing rate. This relation is reversed for long-lived centers. On the basis of earlier data it has been assumed that radiation chemosorption takes place on short-lived centers; however, it is possible that during radiation a stationary concentration of adsorbed centers is created. If the chemosorption on them is irreversible, and during irradiation the occupied centers do not participate in the regeneration and annealing processes, then chemosorption should lead to the adsorption of larger amounts of gas than in the case of the γ-adsorption effect alone. This assumption was tested on the $\gamma–Al_2O_3$ system. The results indicated that both the γ adsorption effect and radiation chemosorption take place not on the free carriers but on defects, i.e., impurities in the forbidden zones. The difference between the two effects may be attributed to the high rate of radiation annealing. (TTT)

11600 RADIOTHERMOLUMINESCENCE OF ICE AND FROZEN AQUEOUS DNA SOLUTIONS. Sharpatyi, V. A.; Nadzhimidinova, M. T.; Tochin, V. A.; Nikol'skii, V. G. (Inst. of Chemical Physics, Moscow). Khim. Vys. Energ.; 3: 469-72(1969). (In Russian).

The radiothermoluminescence method was used to study irradiated DNA–water systems, taken as a model of the cell solution involving one of the most important biopolymers. The specimens were exposed to 1 Mrad of γ radiation of a ^{60}Co source at 77°K. It was found that the method of freezing affects the de-excitation curve: after rapid cooling to 77 and 263°K, the narrow peak in the 133°K region does not appear and the intensity of the luminescence in this region is much lower than in ice prepared and kept at 77°K. It is assumed that, as is the case of the de-excitation of organic compounds, the shape of the de-excitation curve of ice depends strongly on the thawing out of the molecular mobility. Similar tests have been carried out earlier with DNA–propyl gallate solutions, in which the latter acts as a radioprotector with respect to the DNA. Such phenomena are of great interest for understanding the energy transfer processes between components of a system, in which one component exhibits radioprotective properties. (TTT)

11601 EFFECT OF PRELIMINARY IRRADIATION OF ZEOLITES ON THEIR ACTIVITY DURING THE CONVERSION PROCESS OF PROPYLENE. Panchenkov, G. M.; Shauki, M. Kh.; Kuznetsov, O. I.; Kaushanskii, D. A.; Stul, B. Ya. (Inst. for Petrochemical and Gas Industry, Moscow). Khim. Vys. Energ.; 3: 475-6(1969). (In Russian).

Studies were carried out to determine the effect of the irradiation of synthetic zeolites by a ^{60}Co γ source on their catalytic ability and on the composition of the products formed during the conversion of propylene. As the liquid reaction products consist primarily of C_4 to C_9 isoparaffins, it was assumed that the polymerization of propylene is an intermediate stage of its conversion, accompanied by subsequent cracking and hydrolysis. The specimens were heated to 550°C, then irradiated at a dose rate of 1 Mrad/hour. Infrared spectroscopy and gas chromatography of the reaction products indicated that the X and Y type Na and decationized zeolites are not affected by irradiation at the 48 to 150 Mrad level. Exposure of X and Y type Ca zeolites to 48 Mrad increased their catalytic activity by a factor of 2.7 and 2.3, respectively. The degree of conversion of the propylene by a CaX type zeolite exposed to 20 Mrad increases rapidly with respect to the reaction involving unirradiated material, but further increase of the dose has only a slight effect. The composition of the products was unaffected by the irradiation of CaX type material to 20 or more Mrad. (TTT)

11602 RADIOLYSIS OF PHOSPHOROUS ACID ESTERS. Terauchi, K.; Aoti, Y.; Saturi, H. (Osaka Univ.). Tetrahedron Lett.; 58: 5073-6(Dec 1969).

Preliminary results of γ-ray radiolysis of pure liquid trialkyl phosphites, affording alcohol, trialkyl phosphate, and rearranged products are reported. (UK)

11603 OBSERVATION OF A LARGE DOSE RATE EFFECT ON THE OZONE YIELD IN THE RADIOLYSIS OF GASEOUS OXYGEN. Boyd, A. W. (Atomic Energy of Canada Ltd., Chalk River, Ont.); Willis, C.; Cyr, R.; Armstrong, D. A. Can. J. Phys.; 47: 4715-17(15 Dec 1969). (AECL-3486).

The ozone yield from the radiolysis of gaseous oxygen was measured as $G(O_3) = 12.8 \pm 0.6$ at 10^{26} to 10^{27} eV g^{-1} s^{-1} and to be $G(O_3) = 6.2 \pm 0.6$ at 10^{16} eV g^{-1} s^{-1}. The latter result depends on a new determination of the stoichiometry of the oxidation of iodide by ozone. It is proposed that the difference in yields between the two dose rates is due to differences in ion-recombination processes. (auth) (Canada)

11604 ISOTOPE EFFECT IN BROMINE IN PRESENCE OF SCAVENGER. Lal, A. (Banaras Hindu Univ., India). Curr. Sci. (India); 39: 33-4(20 Jan 1970).

Isotope effects were studied in the thermal neutron irradiation of 1,2-dibromoethylene in the presence of a bromine scavenger upon subjection to an electric field. A marked isotope effect was observed in the formation and collection of ^{80}Br and ^{82}Br for various durations of the applied field. (J.G.B.)

11605 A SIMPLE METHOD OF CORRECTING ^{99}Mo BREAKTHROUGH FROM A ^{99m}Tc–^{99}Mo GENERATOR. Lo, Hing-har; Berke, Raymond A.; Potsaid, Majic S. (Havard Medical School, Boston. Massachusetts General Hospital, Boston). Radiology; 93: 1198-9(Nov 1969).

The eluent of a ^{99m}Tc–^{99}Mo commercial generator is routinely checked for contamination by ^{99}Mo. Infrequently a concentration of ^{99}Mo higher than the level permitted by AEC regulations (1 μCi ^{99}Mo/mCi of ^{99m}Tc) was found. A method of reducing the level of ^{99}Mo contamination by passing the contaminated eluent through a second exhausted generator is described. The generator was eluted on four successive days, and the eluent was assayed by each method. The eluent was then decontaminated by passing it through an exhausted generator and assayed a second time. Two methods given for calculating ^{99}Mo contamination correlate well. (M.C.G.)

11606 RADIOLYSIS OF WATER VAPOUR BY LOW-ENERGY HEAVY IONS. Andersen, T.; Olsen, K. J.; Soerensen, G.; Thomsen, P. V. (Univ. of Aarhus, Denmark). Trans. Faraday Soc.; 65: 2958-66(Nov 1969).

Radiolysis of water vapour at low pressure ($\leq 10^{-4}$ torr) has been studied using ion beams from an electromagnetic isotope separator and a 600 keV ion accelerator. Ions used were He^+, Ne^+, Ar^+, K^+, Kr^+, and Xe^+ at 30, 60, and 500 keV. Radiolytic products were investigated both directly in the gas phase by means of emission spectroscopy and indirectly with ESR and chemical analysis of deposits formed by condensing the irradiated vapour. H, OH, O^+, and OH^+ were detected in the gas phase. Hydroxyl radicals were present in deposits formed at temperatures at or below –180°C, hydroperoxy radicals in all investigated deposits, but no electrons were detected. Relative and absolute cross sections for generation of hydroxyl radicals with 60 keV inert gas ions were measured and compared with theoretical calculations for the reaction ion + $H_2O \rightarrow$ OH + H. (auth) (UK)

11607 PRESSURE DEPENDENCE OF THE YIELD OF OZONE FROM THE PULSE RADIOLYSIS OF OXYGEN AT HIGH DOSE RATES. Johnson, G. R. A.; Wilkey, D. D. (Univ. of Newcastle-upon-Tyne, Eng.). J. Chem. Soc., D; 24: 1455-6(17 Dec 1969).

The yields of O_3 (molecules/100 eV) from a high dose-rate radiation pulse in O_2 decreased with increasing O_2 pressure and it was postulated that this is due to a competition between electron capture by O_2 and ion–electron recombination. (auth) (UK)

11608 THE CHEMISTRY OF NUCLEAR RECOIL ^{18}F ATOMS. III. THE AVERAGE ENERGY AND MECHANISM FOR F-FOR-F SUBSTITUTION IN CH_3CF_3. McKnight, Charles F.; Parks, Norris J.; Root, John W. (Univ. of California, Davis). Contract AT(11-1)-34. J. Phys. Chem.; 74: 217-18(Jan 1970).

In an attempt to provide support for results from previous studies involving pressure-dependence studies with perfluorocyclanes that indicated extensive unimolecular decomposition of the products from $^{18}F + CH_3CF_3 \xrightarrow{\text{F-for-F}} (CH_3CF_2^{18}F^*) + {}^{19}F$ (1) in c-C_3F_6 and c-C_4F_8 arising from remarkably large $\bar{E}^{vib}(R_j{}^{18}F)$ values, experiments were carried out involving activation of a single chemical species by both (1) and $T^* + CH_3CF_3 \xrightarrow{\text{T-for-H}} (CH_2TCF_3^*) + H$ (2). The ratio of $k_\alpha(\bar{E})$ values for $(CH_3CF_2{}^{18}F) : (CH_2TCF_3)$ was found to be 2200 ± 300 indicating unambiguously that $\bar{E}^{vib}(CH_3CF_2{}^{18}F) \gg \bar{E}^{vib}(CH_2TCF_3)$. It was concluded that results support a "concerted" mechanism for F- for-F reactions since $\bar{E}^{vib}(R_j{}^{18}F)$ values invariably exceed the various C–F bond dissociation energies by factors of 2 or more. (D.H.M.)

11609 ELECTRONIC ABSORPTION SPECTRA OF CYCLOHEXADIENYL RADICAL IN γ-IRRADIATED SOLIDS AT 77°K. Shida, Tadamasa; Hanazaki, Ichiro (Inst. of Physical and Chemical Research, Yamatomachi, Japan). J. Phys. Chem.; 74: 213-14(8 Jan 1970).

Gamma-irradiated benzene in methanol glass at 77°K yields an absorption band of γ_{max} 3.9 eV that has been assigned to cyclohexadienyl radical. Another band at about 2.2 eV was observed and attributed to the cyclohexadienyl radical. The absorption spectra of the cyclohexadienyl radical in pure benzene corresponded well with the absorption spectra of the alcoholic solution. (D.H.M.)

11610 THE ^{60}Co γ-RAY RADIOLYSIS OF AQUEOUS SOLUTION OF $H_2 + O_2$. DETERMINATION OF $G_{e_{aq}^-} + G_H$ AT pH 0.46 TO 6.5. Sehested, Knud; Corfitzen, Hanne (Atomic Energy Commission Research Establishment, Risoe, Denmark); Fricke, Hugo. J. Phys. Chem.; 74: 211-13(8 Jan 1970).

Results of a study of the γ radiolysis of aqueous solution of H_2 + O_2 show that when the system is irradiated under conditions of scavenging of all the free radicals, $G(H_2O_2)$ equals 3.66. The $G_{e_{aq}^-} + G_H$ calculated from $G(H_2O_2)$ in solutions of O_2 and H_2 and from G (Fe(III)) in air-free solutions of $FeSO_4$ are given at pH from 0.46 to 6.50. (D.H.M.)

11611 MAGNETIC RESONANCE STUDIES OF THE OXIDATION AND REDUCTION OF ORGANIC MOLECULES BY IONIZING RADIATIONS. Box, Harold C.; Freund, Harold G.; Lilga, Kenneth T.; Budzinski, Edwin E. (Roswell Park Memorial Inst., Buffalo). J. Phys. Chem.; 74: 40-52(8 Jan 1970).

By maintaining organic compounds at low temperature (4.2°K) it is often possible to stabilize oxidation and reduction products produced by ionizing radiation. The products were observed by electron spin resonance (esr) and in some cases by electron-nuclear double resonance (ENDOR) spectroscopy. The oxidized and reduced

species observed in irradiated single crystals of thiourea derivatives, several organic disulfides, thiodiglycolic acid, glycine, glycine HCl, and two dicarboxylic acids are enumerated. Some G values for ion production at 4.2°K are also given. The results are discussed in terms of the following processes: electron attachment, dissociative electron attachment, intramolecular transfer of holes, and anion degradation. (auth)

11612 RATE CONSTANTS AND TRANSIENT SPECTRA IN THE GAS-PHASE REACTIONS OF HYDROGEN ATOMS. SUBSTITUENTS EFFECTS IN MONOSUBSTITUTED BENZENES. Sauer, Myran C. Jr.; Mani, Inder (Argonne National Lab., Ill.). J. Phys. Chem.; 74: 59-63(Jan 1970).

Transient spectra and rate constants were obtained, using the pulse-radiolysis technique, for the gas phase reactions of hydrogen atoms with a series of monosubstituted benzenes, naphthalene, the xylenes, and pyridine. Arrhenius parameters were determined for most of these compounds by varying the temperature within the range 25 to 120°C. The rate constants for $H + C_6H_5X$ can be correlated with the Hammett σ values of the substituents, X, and the nature of the correlation indicates that the hydrogen atom is electrophilic in these reactions. (auth)

11613 REACTION INTERMEDIATES AND PRODUCTS IN THE RADIOLYSIS OF PHENYL ACETATE AT 77°K. Noro, Yasuyuki; Ochiai, Mitsuru; Miyazaki, Tetsuo; Torikai, Ayako; Fueki, Kenji; Kuri, Zen-ichiro (Nagoya Univ., Japan). J. Phys. Chem.; 74: 63-7(8 Jan 1970).

The radiolysis of phenyl acetate at 77°K was studied by product analysis and the observation of reaction intermediates. Ionic species are produced by the γ irradiation of phenyl acetate glass at 77°K and are observed by ESR and optical spectroscopy. The species are easily photobleached by infrared light and change into acetyl radicals. The reaction is explained by the neutralization of phenyl acetate cation and anion. When MTHF glass containing phenyl acetate is γ-irradiated at 77°K, a doublet ESR spectrum with a line separation of 22 G is obtained and is assigned to the phenyl acetate anion. When sec-butyl chloride glass containing phenyl acetate is γ-irradiated at 77°K, a doublet ESR spectrum with a line separation of 14 G is obtained and is assigned to the phenyl acetate cation. The main products in the radiolysis of phenyl acetate at 77°K are anisole, phenol, and hydroxyacetophenone. The G value of anisole in the radiolysis in the polycrystalline state is twice that in the glassy state, while the G value of phenol in the polycrystalline state is half that in the glassy state. (auth)

11614 DIELECTRIC PROPERTIES OF γ-IRRADIATED CRYSTALS OF TRIGLYCINE SELENATE AND TRIGLYCINE FLUOROBERYLLATE. Sirota, N. N.; Varikash, V. M. (Inst. Of Physics of Solids, Minsk. Minsk Radio-Technical Inst.). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 5, 124-6 (1969). (In Russian).

Studies of γ-radiation effects on the dielectric properties of triglycine selenate and triglycine fluoroberyllate showed that γ radiation reduced the dielectric penetrability, ϵ_{22}, in the phase-transition region. In the other regions, the γ irradiation increased ϵ_{22}. Following irradiation, dielectric penetrabilities ϵ_{11} and ϵ_{33} of triglycine selenate increased. Annealing of γ-irradiated crystals changed, partially, the dielectric penetrability. However, it never reverted to the initial magnitude. (tr-auth)

11615 DISCOVERY AND HISTORY OF ^{252}Cf. Fields, Paul R. Argonne Nat. Lab. Rev.; 5: 106-8(Oct 1969).

The production of ^{252}Cf by capture of 13 successive neutrons by ^{239}Pu is discussed. Production in accelerators, reactors, and thermonuclear explosions is described. (M.C.G.)

11616 PROCESS FOR MODIFICATION OF POLYOLEFIN MATERIALS. (to Japan Atomic Energy Research Inst.). British Patent 1,173,638. 10 Dec 1969. Priority date 1 Oct 1966, Japan.

A process is described for the production of graft polymers of a polyolefin by contacting the polyolefin with butadiene combined with styrene and/or acrylonitrile and subjecting the polyolefin to ionizing radiation either before or during the reaction. The process is carried out at a temperature of 0 to 100°C. (B.L.M.)

11617 THE HOT-ATOM CHEMISTRY OF ^{35}S PRODUCED BY THE ^{35}Cl(n,p)^{35}S REACTION IN MIXED CRYSTALS OF POTASSIUM CHLORIDE AND POTASSIUM BROMIDE. Hobbs, John Robert. Durham, N. H.; Univ. of New Hampshire (1968). 222p.

Thesis.

The hot-atom chemistry of recoil ^{35}S from the ^{35}Cl(n,p)^{35}S reaction in mixed crystals of KCl-KBr was investigated. The oxidation states of the ^{35}S were separated by dissolution of one-half of a sample in a basic carrier solution of S^{2-} and SO_3^{2-} ions and the other half in a basic solution without carriers. In the presence of S^{2-} carrier, neutral sulfur radioactivity (S^0) is rapidly converted to S^{2-}; in the absence of S^{2-}, it is converted by water to SO_4^{2-} and/or SO_3^{2-}. The S^{2-} was precipitated as CdS centrifuged, oxidized to SO_4^{2-} with hypochlorite ion in basic solution, and the SO_4^{2-} precipitated as $BaSO_4$. The difference between the relative S^{2-} yields of the aliquots dissolved by the two dissolution procedures gave the relative S^0 yield. The results indicate that in the 0 to 30 mole % KBr region there are competing oxidation and reduction reactions. The oxidation-reduction reactions occurring in the low KBr region are thought to be due to changes in the concentration and nature of defects resulting from changes in structure upon mixed crystal formation. These conclusions are consistent with independent studies of the properties of the alkali halides and their mixed crystals. Differences in the nature and concentrations of defects in the low KBr region of the mixed crystals have been observed. Thermal annealing studies have shown that very little annealing takes place at 75°C except for samples with 0 to 20 mole % KBr. Increasing the annealing temperature to 215°C increased the S^+ and S^- yields and decreased the S^0 yield. These observations are consistent with the known behavior of defects in alkali halides upon thermal annealing. Thus, the chemical stabilization of the recoil atom was found to be dependent on the composition of mixed crystals of KCl–KBr. The stabilization is related to the environment in which the recoil atom loses its excess energy and this energy loss is determined by the nature of the defects in the crystal. (Diss. Abstr.)

11618 COPOLYMERIZATION OF VINYL CHLORIDE AND OLEFIN. Kagiya, Tsutomu (Kyoto Univ.); Hagiwara, Oko. Enka Biniiru To Porima; 9: No. 5, 7-14(May 1969). (In Japanese).

Prior studies on copolymerization of vinyl chloride (VC) and olefin, using mostly radical initiators or organometallic compounds, are reviewed, and recent studies on irradiated copolymerization of VC and α-olefins (e.g., ethylene, propylene, and isobutylene) and copolymerization of VC and oligomer of allyl chloride are reported. In the copolymerization of VC and lower olefins, the copolymers were soft and amorphous, but the copolymer of VC and allyl chloride -oligomer was hard. Copolymerization of VC and olefins is a very excellent method for reforming VC-resins. Future problems concerning the synthesis of copolymers, structures and properties, particularly thermal properties are discussed. (NSA of Japan)

11619 A STUDY OF THE PHOTOLYSES AND CHARGE-TRANSFER COMPLEXES OF IODINE, HYDROGEN IODIDE, AND SOME ALKYL IODIDES IN GLASSY MATRICES. Lantz, Thomas Edward. Madison, Wis.; Univ. of Wisconsin (1969). 92p.

Thesis.

The photolyses by 254 nm light of HI, CH_3I, and C_2H_5I individually in glassy 3-methylpentane (3-MP) at 77°K were studied spectrophotometrically in the visible and uv regions to determine what reactions occur and what species are responsible for the metastable peaks appearing at 77° and during the warming of the photolyzed solutions. A spectrophotometric study was made of the C-T (charge-transfer) complexes of I_2 with several donors in 3-MP at 82°K. The isopropyl iodide $\cdot I_2$ complex has peaks at 267 and 307 nm in a ratio of 1.2 to 1; the complexes with the other alkyl iodides were similar but shifted slightly in their wavelengths. The other donors, benzene, toluene, mesitylene, propylene, ethylene, acetone, and ethyl bromide, gave peaks similar to those reported at room temperature. In a study of iodine aggregation it was found that when a dilute solution of I_2 in pure 3-MP is cooled rapidly to 77°K, the absorption spectrum is essentially the same as that at 300°K, giving a pink solution. When this solution is warmed to about 90°K it turns yellow, giving a broad absorption in the 250 to 550 nm region, similar to that of a 60 nm thick film of solid I_2. As a further test of aggregation, reaction of the I_2 with the 3-MP was initiated by the ^{127}I $(n,\gamma)^{128}$I process at low temperature, both the pink and the yellow states being tested. In the pink state 70% of the ^{128}I was in the form of alkyl iodides while in the yellow state only 25% so reacted, indicating that in the latter case aggregates of I_2 molecules had absorbed the recoil energy and charge, preventing reaction with the matrix. (Disser. Abstr.)

11620 THE EFFECT OF INTERFACIAL ENERGETICS ON THE PHYSICAL PROPERTIES OF SILICA–POLYDIMETHYL SILOXANE COMPOSITIES. Chahal, Ramlal Singh. Montreal; McGill Univ. (1969).

Thesis.

The nature of the interfacial phenomena in silica-polydimethyl siloxane composites and the relationships between this interfacial interaction and the mechanical properties of composites has been investigated. Interfacial energies were expressed in terms of the

heats of adsorption of a model compound of the polymer (octamethyl cyclotetrasiloxane), on the silica surfaces and were determined by vapor phase chromatography. Silicas with different interaction energies were prepared by reaction with normal alcohols and chlorosilanes. Relaxation and tensile moduli measurements were made on uncrosslinked and crosslinked composites containing silicas with different interaction energies. Crosslinking was done with benzoyl peroxide and with γ radiation. A mathematical relationship was obtained describing the relaxation moduli of uncrosslinked composites in terms of the interaction energies and the concentration of the silicas. Tensile moduli of crosslinked composites were strongly influenced by polymer-silica covalent bonding and were determined by the relative numbers of polymer-silica and polymer-polymer covalent linkages. (Diss. Abstr.)

11621 ELECTRON SPIN RESONANCE STUDIES ON GAMMA-IRRADIATED NUCLEIC ACID CONSTITUENTS AND RELATED COMPOUNDS. Bernhard, William Allen. University Park, Pa.; Pennsylvania State Univ. (1968). 83p.

Thesis.

Free radicals produced in solid-state nucleic acid constituents by γ irradiation were studied from two different perspectives: free radical identification and free radical production-destruction. Identification of free radicals in 3′ cytidylic acid was done on single crystals by ESR spectroscopy. Production and destruction experiments were done on a group of pyrimidines related to thymine. The primary radical formed in 3′ cytidylic acid at room temperature has the unpaired electron localized on a carbon atom and exhibits hyperfine interaction with one α proton and one β proton. A detailed comparison of the g tensor and the α proton hyperfine tensor with the known crystal structure showed that the free radical most probably has the unpaired electron on C_4' of the ribose sugar moiety. The C_4' radical would result by breaking open the ribose ring at the $C_4'-O_4'$ bond. Preliminary ESR studies at liquid nitrogen temperature showed the presence of a free radical that slowly decays at 77°K. For some crystal orientations in the magnetic field this radical has a g value of at least 2.054 and a doublet splitting of 120 gauss. It was concluded that the radical giving rise to this low temperature ESR spectral component involves as unpaired electron on the phosphate moiety which has hyperfine coupling with the phosphorous nucleus. Free radical production and destruction experiments were performed on two unsaturated pyrimidines, thymine and 6-methyluracil, and their respective saturated forms, 5,6-dihydrothymine (DHT) and 5,6-dihydro-6-methyluracil (DH6MU). The free radical produced by γ-irradiation in either unsaturated pyrimidine can also be produced in the dihydro derivative. Dose-response curves for free radical production in DHT and DH6MU were reported. The G-values of 0.85 for DHT and 0.45 for DH6MU were found to be appreciably different from the G-values of the respective unsaturated form: 0.05 for thymine and 0.03 for 6-methyluracil. For these radicals, therefore, a significant dependence of radical formation on the parent compound exists. In contrast, it was found that destruction of either radical was not significantly dependent on the parent molecule from which it was derived. The rate of production of chromophore by γ irradiation of polycrystalline DHT and DH6MU has been determined. Samples were dissolved in water after irradiation and analyzed by the uv absorption in the 260 mμ region. Using a bio-assay, the chromophore in DHT was proved to be thymine and, therefore, in DH6MU assumed to be 6-methyluracil. The G-value for production of both thymine from DHT and 6-methyluracil from DH6MU is 0.9. The close correspondence between G-values for radical production in these dihydropyrimidines and the G-values for their conversion to unsaturated compounds in the solid state suggests the possibility that the radicals are intermediates in the conversion process. There are two radicals produced by γ irradiation in DHT. The conversion of one of these radicals, 6-keno-5-hydrothymine, into the other, 5-keno-6-hydrothymine was monitored in the 90 to 130°C temperature range. The activation energy for this free radical conversion was found to be 23.1 kcal. Three mechanisms of conversion are discussed. (Disser. Abstr.)

11622 WOOD-PLASTIC COMBINATIONS PREPARED FROM BEECHWOOD. Proksch, E. (Reaktorzentrum, Seibersdorf, Austria). Holzforschung; 23: 93-8(Jun 1969). (In German).

Samples of beechwood were impregnated with monomeric systems based on methyl methacrylate and subsequently cured by radiation. Polymer loading of up to 70 parts/100 parts of wood were obtained, which was equivalent to almost complete impregnation. Doses necessary for complete polymerization under realistic irradiation conditions ranged between 2 and 4 Mrads. By this procedure, the hardness of beechwood was increased 3 to 4 fold, compressive and bending strengths up to 70%, and at the same time dimensional change upon swelling in water was reduced to about 60% of its original value. Methyl methacrylate without additives gave the best products. Use of prepolymerized methyl methacrylate reduced the end losses due to evaporation during treatment but yielded products of lower dimensional stability. Chemical curing of the same prepolymer resulted in almost identical products. (auth)

11623 IRRADIATED SOLID PHASE POLYMERIZATION AT LIQUID HELIUM TEMPERATURE. Ishigure, Kenkichi; Tabata, Yoneho (Tokyo Univ.). FAPIG (Tokyo); No. 53, 68-70(May 1969). (In Japanese).

The solid-phase γ-induced polymerization of isobutene (1), acetylene (2), β-propiolactone (3), methacrylonitrile (4), acetaldehyde (5), propylene oxide (6) and acrylonitrile (7) were investigated at the temperatures of liquid nitrogen (77°K) and of liquid helium (4.2°K). In the crystal state, monomers 1,2, and 4 polymerized at 77°K, but no polymer was obtained at 4.2°K. On the other hand, monomer 3 and 5 gave polymers at both temperatures, and it was found the the ir spectra of the polymers obtained from 3 were different by treatment after the irradiation. In the glass state, monomer 7 polymerized rapidly in 2-methyltetrahydrofuran at 77°K, but did not polymerize at 4.2°K. On the contrary, monomer 6 polymerized in methylene chloride at both temperatures, and the amorphous polymer was obtained. From the experimental results at 77°K and 4.2°K, in the crystal state of 7, it was found that both the initial polymerization rate of 7 and the saturated yield of polymer were lower but the molecular weight of the obtained polymer was larger at 4.2°K, than at 77°K. Further the polymerizations of 7 by two or three stage irradiation at different temperatures were studied and considered. (NSA of Japan)

11624 MECHANISM AND KINETICS OF RADICAL REACTIONS IN POLYMERS. Dole, M.; Boehm, G. G. A.; Waterman, D. C. (Northwestern Univ., Evanston, Ill.). European Polymer J.; Suppl., 93-104(1969). (COO-1088-31).

Free radical generation and decay in irradiated polymers with emphasis on polyethylene are discussed. The effects of irradiation at 77°K and the reactions of free radicals on heating above 77°K are reported. The discussion of free radical reaction mechanisms are limited to 3 main classes: (1) decay between free radicals that are formed so close together that they can recombine (or disproportionate) without migration either of the free radical center or of the polymer segment or chain as a whole; (2) free radicals as by hydrogen atom migration, but without chain migration; and (3) free radical decay between free radicals trapped at immobile sites so that migration of the free radical chain leading to a displacement of the free radical center is required. (24 references) (B.L.M.)

11625 STUDY OF THE REPOLARIZATION EFFECT IN IRRADIATED CRYSTALS OF TRIGLYCINE SULFATE. Hilczer, B.; Sobczak, K. (Inst. of Physics, Poznan, Poland. Mickiewicz Univ., Poznan, Poland). Poznan. Tow. Przyj. Nauk Pr. Kom. Mat.-Przyr.; 11: No. 4, 93-102(1968). (In Polish).

The time t_s taken to repolarize in fields up to 18 kV/cm is related to electric field strength E by the following equation: $1/t_s = 1/t_0 \exp(-\alpha/E)$, where t_0 is the repolarization time in a field of infinitely high voltage and α is a constant dependent on temperature and thickness of the specimen. For large switching field strengths (more than 18 kV/cm in the case of triglycine sulfate) the repolarization time is a linear function of electric field E: $1/t_s = kE$. The results of studies of the effect of x-ray and γ-ray irradiation on the repolarization of triglycine sulfate crystals in low electric fields are reported. The results of measurements of aged triglycine sulfate specimens both pure and irradiated indicate that the shape of the time dependence of the repolarization current for the pure aged crystals depends on the voltage of the electric field, switching direction of polarity, and on the polarity of the current with respect to polarity of the reinforced polarization. In specimens irradiated with doses of 0.7×10^5, 1.4×10^5, and 2.1×10^5 R this change in polarization direction is rendered more difficult. The relationships for γ radiation, governed by the ratios $\Delta t_s/t_s = t_s^* - t_s/t_s$ and $\Delta I_{max}/I_{max} = I^*_{max} - I_{max}/I_{max}$, are presented in figures. The defects introduced into the crystal lattice by irradiation weaken the state of polarization reinforcement, which prevails in spontaneously aged ferroelectric crystals, lower the switching current, and increase the repolarization time. (JPRS)

11626 CHAIN REACTIONS IN THE DISSOLUTION OF REACTIVE PHOSPHORUS IN DIMETHYL DISULFIDE UNDER THE INFLUENCE OF γ RADIATION. Scheffler, M.; Henglein, A. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Z. Naturforsch.; 25b: 103-4(Jan 1970). (In German).

If red phosphorus, suspended in dimethyl disulfide at a concentration of 125 mg/ml, were irradiated with ^{60}Co γ radiation at a dose rate of 1.3×10^5 R/hr at 20°C, after 12 hours a clear solu-

tion was obtained. A chain reaction mechanism for the dissolution was formulated. (M.C.G.)

11627 RADIATION-INDUCED OXIDATION OF METHANE IN AQUEOUS SOLUTIONS. Ahmad, Mukhtar (Imperial Coll. of Science and Tech., London). Sci. Ind.; 6: 57-73(Jan-Apr 1968).

The γ radiolysis of methane–oxygen aqueous solutions has been studied in some detail. Secondary reactions, involving products of the radiolysis, viz formaldehyde, commenced at quite low total doses in solutions saturated with gases at atmospheric pressure. This was due to the low reactivity of methane towards hydroxyl radicals. When the methane–oxygen concentration in solution was increased by a factor of about 20, the products and G-values were at pH 5.5, HCHO = 0.55 ± 10%; CH_3OOH = 1.65 ± 5%; H_2O_2 = 2.1 ± 1% and at pH 2.0 HCHO = 1.2 ± 5%; CH_3OH = 1.3 ± 50%; HCOOH = 0.98 ± 25% and H_2O_2 = 3.5 ± 1%. The effects of added nitrous oxide and hydrogen on the yields of products were also investigated. Attempts have been made to elucidate mechanisms for the formation of the observed products. (auth)

11628 PROSPECTS FOR FURTHER CONSIDERABLE EXTENSION OF THE PERIODIC TABLE. Seaborg, Glenn T. (Atomic Energy Commission, Washington, D. C.). Isotop. Radiat. Technol.; 7: 251-65(Spring 1970).

The possibilities of extending the periodic table to elements in the region of atomic number 114 are discussed, and the physical and chemical properties of these potential new elements, as well as of those up to number 132, are predicted. Particularly interesting is the concept of an "island of stability" surrounded by a "sea of instability," with maximum stability of approximately Z = 110, with suggested half-lives of as long as 10^8 years. (auth)

11629 RADIATION CHEMISTRY OF HYDROCARBONS. PART 18. HEXANE–N_2O. Menger, Andre; Gaeumann, Tino (Eidgenoessische Technische Hochschule, Lausanne, Switzerland). Helv. Chim. Acta; 52: 2477-86(10 Dec 1969). (In German).

N_2O has the following effects on the radiolysis of light and heavy hexane: It decreases the bimolecular part of the hydrogen production. A corresponding N_2-production amounts to the double of this decrease. The speed of competition is very much faster at higher temperature. The amount of C–C bond split yielding alkyl radicals is decreased but not suppressed. The initial amount of hexyl radicals formed is not changed and shows no isotope effect, whereas an additional production of these radicals shows such an effect. They are probably formed by the abstraction by OH radicals that are products of the neutralization reaction of N_2O^- with the hexyl cation. This additional amount contributes mainly to the 3-hexyl isomer. The part of the additional hexene formation that exceeds the amount produced by disproportionation from hexyl radicals is formed in a unimolecular process yielding water as the second product. This is a main product, hexanols and hexanones were not found. A partial product balance involving hydrogen, hexyl, and hexene is presented. The disproportionation/combination ratio for hexyl radicals is according to this balance 0.75. (auth)

11630 RADIOLYSIS AND CRYSTALLIZATION OF ETHYLENE–ACRYLIC ACID COPOLYMERS. Otocka, E. P.; Kwei, T. K.; Salovey, R. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Makromol. Chem.; 129: 144-56(5 Dec 1969).

The melting points of five ethylene–acrylic acid copolymers were analyzed by the theories of Flory. The results are consistent with exclusion of the acid groups from the crystal. Radiation with 1-MeV electrons was effective in cross linking the copolymers, although the mechanism of cross linking was different from that in simple polyethylenes. Annealing the samples at 65°C resulted in a stable lamellar thickness. Changes in the post-irradiation fusion endotherms of annealed samples suggest reorganization of decarboxylated polymer in the secondary crystals. (auth)

11631 ELECTRON IRRADIATION STABILITY OF POLYSULPHONE. Davis, A.; Gleaves, M. H.; Golden, J. H.; Huglin, M. B. (Explosives Research and Development Establishment, Waltham Abbey, Eng.). Makromol. Chem.; 129: 63-72(5 Dec 1969).

It was found that polysulfone is particularly stable to electron irradiation compared with other polymer systems. This was reflected in the retention of mechanical properties (flexural strength and modulus) even after doses of 200 Mrads. However, electron irradiation produced significant changes in the chemical structure. The polymer increased in molecular weight and gelled after 80 Mrads. Doses greater than 200 Mrads gave a constant gel content of about 70 percent indicating that scission as well as crosslinking processes were important. G-values for scission and crosslinking were calculated to be 0.08 and 0.16, respectively. The discoloration of diphenylpicrylhydrazyl solutions by solutions of irradiated polysulfone indicated the accumulation of groups containing an active hydrogen. These groups were deduced to be phenolic. The low G-value for total gas (0.01) indicated the stability of polysulfone but the gas composition suggests that the three linkages, sulfone, ether, and isopropylidene between the phenylene rings are affected by irradiation. Possible reactions involving these linkages and the processes that may account for the experimental observations are advanced and discussed. (auth)

11632 MOLECULAR WEIGHT DISTRIBUTIONS IN RADIATION-INDUCED POLYMERIZATION. III. γ-RAY-INDUCED POLYMERIZATION OF STYRENE AT LOW TEMPERATURES. Huang, Robert Y. M.; Westlake, John F. (Univ. of Waterloo, Ont.). J. Polym. Sci., Part A-1; 8: 49-61(Jan 1970).

The kinetics of the γ-radioinduced polymerization of styrene was studied at radiation intensities of 8×10^4, 2.4×10^5, 3.1×10^5, and 8.3×10^5 rad/hr over a temperature range of −10 to 30°C. The water content of the irradiated samples varied from 1.0×10^{-3} to 7.5×10^{-3} mole/l. The power dependence of the rate of polymerization on the dose rate at −10°C varied from 0.53 to 0.71 as the water content of the sample varied from 7.5×10^{-3} to 1.0×10^{-3} mole/l. A value of 3.1 kcal/mole was determined for the overall activation energy. Molecular weight distribution studies by gel-permeation chromatography indicated the presence of two distinct peaks. The contribution of each peak was dependent on specific experimental parameters. Kinetic data and molecular weight distribution data indicate the coexistence of two propagating species. Analysis of the data strongly suggests that a free-radical mechanism and a cationic mechanism are involved. (auth)

11633 RADIOLYSIS OF POLY(VINYL CHLORIDE). Salovey, R.; Luongo, J. P. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Polym. Sci., Part A-1; 8: 209-14(Jan 1970).

Allyl free-radical intermediates were detected by ultraviolet absorption at 255 mμ in poly(vinyl chloride) irradiated at −196°C and stored at 25°C. In vacuum at 25°C, allyl radicals were converted into polyenyl free radicals and polyenes. From the nature of allyl radical decay in vacuum, radical chain transfer between polyenyl radicals and poly(vinyl chloride) was inferred. Allyl and polyenyl free radicals were scavenged by oxygen on post-irradiation storage in air. (auth)

11634 RADIATION CHEMISTRY OF AQUEOUS POLY(ETHYLENE OXIDE) SOLUTIONS. I. King, P. A.; Ward, J. A. (Union Carbide Corp., Tuxedo, N. Y.). J. Polym. Sci., Part A-1; 8: 253-62(Jan 1970).

The γ radiolysis of aqueous high molecular weight poly(ethylene oxide) solutions has been studied. The crosslinking and eventual gelation of these solutions appears to occur via an indirect effect. Solubility measurements on the gelled solutions showed that the ratio of cross linking to degradation is about four. $G(H_2)$ increased from 1.3 in neutral solutions to 3.5 in 0.1 N HCl solutions. In heavy water solutions, HD was the major gaseous product. Solvated electrons were not important precursors to hydrogen at neutral pH. Intramolecular crosslinking appears to be an important phenomenon in solutions of high molecular weight polymers. (auth)

11635 RADIOLYSIS OF MYO-INOSITOL SOLUTIONS. Criddle, W. J.; Ward, E. (Univ. of Wales, Cardiff). J. Chem. Soc., B; No. 1, 40-1(1970).

The effects of γ-radiation on myo-inositol in aqueous solution in the presence and absence of oxygen and in nitrous oxide were studied. Although yields were variable, myo-2-inosose (2,4,6/3,5-pentahydroxycyclohexanone) was shown to be the predominant primary product regardless of the conditions used, which indicates a strong steric influence on the reaction path. Other products varied with the conditions used, but idaric acid was always produced. Subsequent reactions were complex but ultimately led to carbon dioxide. Possible mechanisms for the primary reactions are discussed. (auth) (UK)

11636 THERMAL DEGRADATION OF POLY(METHYL METHACRYLATE) IRRADIATED BY ULTRAVIOLET OR GAMMA RAYS. David, C.; Fuld, D.; Geuskens, G.; Charlesby, A. (Univ. Libre, Brussels). Eur. Polym. J.; 5: 641-8(Oct 1969). (In French).

Films of poly(methyl methacrylate) ~55 μ thick (obtained by evaporation of benzene solutions of the polymer) were irradiated with ^{60}Co γ rays at a flux of 0.6 Mrad/hr or by uv light from a low-pressure mercury vapor lamp. Depolymerization was studied after γ doses of 4 Mrad. When polymethyl methacrylate was γ-irradiated and then warmed to 160°C, thermal depolymerization occurred. It was initiated at unstable points formed during irradiation. The fraction of polymer volatilized was independent of the dose and of the initial molecular weight. Similar treatment of a

sample exposed to uv radiation led also to production of monomer but with a lower yield. Thus γ radiation has a more profound effect on the formation of unstable structures in polymethyl methacrylate. (BBB)

11637 ELECTRON SPIN RESONANCE STUDIES OF ELECTRON-TRAPPING BY CATIONS IN SOME SILVER AND CADMIUM SALTS. Symons, M. C. R.; Eachus, R. S. (Univ. of Leicester, Eng.). J. Chem. Soc., D; No. 2, 70-1(Jan 1970).

A species closely resembling the cation Cd^+ was detected in γ-irradiated $CdCO_3$ at 77K, and identified as $(CdCO_3)^-$, with about 80% of the spin-density on Cd; other cadmium and silver salts gave species with cation spin-densities ranging from 2 to 80%. (auth) (UK)

11638 E.S.R. STUDY OF ALLYL-TYPE RADICALS OBSERVED IN IRRADIATED POLYCRYSTALLINE THIOUREA ADDUCTS OF CYCLOHEPTANE AND CYCLOHEXENE. Heicke, G. A.; Fantechi, R. (EURATOM–CCR, Ispra, Italy). Mol. Phys.; 18: 1-10(1970).

Allyl type radicals were observed as the final irradiation products of both cyclohexene and cycloheptane included in thiourea. In the cyclohexene adduct the cyclohexenyl radical appears to be formed straight away, while in the cycloheptane adduct the cycloheptyl radical is formed first and, except at low temperatures where it is stabilized, changes to an allyl type radical without further irradiation. Consideration of the temperature dependence of the β splittings, together with a comparison between the splittings observed in these two radicals and those of other alkyl radicals, leads to the conclusion that the motion of the β methylene groups about the bonds joining them to the π-bonded section of the radical is anisotropic, even when all four β protons appear to be equivalent. (auth) (UK)

11639 KINETICS OF HIGH-INTENSITY ELECTRON-BEAM COPOLYMERIZATION OF A DIVINYL URETHANE AND 2-HYDROXYETHYL METHACRYLATE. Labana, S. S. (Ford Motor Co., Dearborn, Mich.). J. Polym. Sci., Part A-1; 8: 179-93 (Jan 1970).

The kinetics of the electron-beam-induced copolymerization of di(2'-methacryloxyethyl)-4-methyl-m-phenylenediurethane (DVU) with 2-hydroxyethyl methacrylate (HEMA) were studied. Monomer mixtures containing 1.96 to 82.8% DVU have been described at dose rates of 1.7 to 17 Mrad/sec with the use of 270-kV electrons. Based on rates of conversion, gel formation, and intensity-rate data, a kinetic scheme is proposed in accord with a model that undergoes unimolecular termination and for which the copolymerization and gel formation take place in a crosslinked network swollen with monomers. The rate of gel formation is: $\ln[(1+g)/(1-M_2g)] = A(1+M_2)t$, where g is the gel fraction, M_2 is the mole fraction of DVU in the monomer charge, and A is $k_p k_i/k_t$. Up to 55% conversion, the rate of disappearance of unsaturation for concentrated DVU solutions ($M_2 > 0.03$) is: $\ln[M_0/M(1-M_2g)] = A(1+M_2)t$, where M is the total unsaturation. For dilute solutions of DVU, the rate expression for pregel copolymerization simplifies to: $\ln(M_0/M) = A(1+M_2)t$. These results show that at a certain optimum concentration of monovinyl monomer—70% in the present system—both rapid reaction rates and complete copolymerization occur. Because of the inability of gel bonds to undergo polymerization, a limiting conversion is reached for copolymerizing mixtures containing insufficient monovinyl monomer. (auth)

11640 RADIATION-INDUCED POLYMERIZATION OF PENTOXANE IN THE SOLID STATE. Nishii, Masanobu; Hayashi, Koichiro; Okamura, Seizo (Japan Atomic Energy Research Inst., Osaka). J. Polym. Sci., Part B; 7: 891-5(Dec 1969).

The solid state polymerization of pentoxane by γ irradiation was studied and compared with that of trioxane and tetroxane. The rate of polymerization decreased gradually with the time of polymerization. No influence of atmosphere was observed. The maximum rate of polymerization was found to be near the melting point of pentoxane (T_f). The overall activation energy was estimated to be 7.9 kcal/mole. The influence of temperature on pentoxane polymerization was similar to that of trioxane and tetroxane. It was concluded that the activation energies of the chain propagation reaction in the post-polymerization for all three monomers have similar values. The polymer obtained was a crystalline polyoxymethylene oriented three-dimensionally with a melting point 178 to 182°C. (P.C.H.)

11641 RADIATION POLYMERIZATION OF METHYL METHACRYLATE IN WOOD: EFFECT OF HALOGEN–ORGANIC COMPOUNDS ON POLYMERIZATION RATE. Pesek, Miroslav; Jarkovsky, Jaroslav; Pultar, Frantisek (Inst. of Physics, Prague). Chem. Prumysl; 19: 503-6(Nov 1969). (In Czech).

The rate of methylmethacrylate polymerization in various types of wood (spruce, pine, poplar and beech) was measured. The effects of radiation dose and some solid halogen-containing compounds on the polymerization rate in wood was followed. It was found that the dose necessary for complete conversion in methylmethacrylate polymerization is the lowest for spruce wood (1.5 to 2 Mrad). The induction period was practically absent in this case. For the other wood the dose of 2 to 2.5 Mrad was necessary for complete conversion. Polymerization proceeded better in the presence of water than in dry wood. The presence of some solid halogen-containing organic compounds dissolved in methylmethacrylate promoted the polymerization. (auth)

11642 PREPARATION OF SOME ^{38}Cl LABELLED CHLORINATED HYDROCARBONS BY NEUTRON IRRADIATION AND GAS CHROMATOGRAPHY. Black, A.; Morgan, A. (Atomic Energy Research Establishment, Harwell, Eng.). Int. J. Appl. Radiat. Isotop.; 21: 5-10(Jan 1970).

The preparation of chlorine-38-labeled chlorinated hydrocarbons for use in metabolic investigations with human subjects was investigated. Samples of methylene chloride, chloroform, carbon tetrachloride, ethylene dichloride, acetylene tetrachloride, methyl chloroform, trichloroethylene, and tetrachloroethylene were irradiated with thermal neutrons and the yield of radioactive organic material measured in each case. The radioactive organic reaction products were separated and identified by gas chromatography and their overall yields determined. The yield of the radioactive parent material varied from 9 per cent in the case of methyl chloroform to 36 per cent for tetrachloroethylene. (auth) (UK)

Radiochemistry

11643 (INR–1069) EXPERIMENTS ON EVALUATION OF A METHOD FOR DETERMINING THE RADIOCHEMICAL PURITY OF $Na^{131}I$. Pasternak, Antoni (Institute of Nuclear Research, Warsaw (Poland)). 1969. 22p. (In Polish). Dep. CFSTI (U. S. Sales Only).

An interlaboratory study was performed for the estimation of the influence of some factors on results obtained in determination of the radiochemical purity of $Na^{131}I$ using the "pharmacopoeial" method. The content of iodides was controlled in two samples, one stabilized with $Na_2S_2O_3$ and the other unstabilized. The method under control was ascending paper chromatography using 75% aqueous methanol solution as developer. A drop of carrier (1 g $NaHCO_3$, 0.1 g KI and 0.2 g KIO_3 in 100 ml H_2O) was placed on the start of chromatographic strip. Analysis of variance was a base for elaboration of an experimental scheme that made it possible to obtain an estimate of the influence on the results of the factors inseparably connected with the method itself, such as with activity measurements, time and specific "climate" of laboratories, the factors that have influence on the reproducibility and repeatability. The results and variances for individual stages of the experiment with estimation of their significance are collected in tables. The distinct differences between stabilized and unstabilized samples were established. (auth)

11644 MOLECULAR FLOW OF GASES OF SHORT-LIVED RADIOACTIVE NUCLIDES. Grover, J. Robb (Brookhaven National Lab., Upton, N. Y.). J. Inorg. Nucl. Chem.; 31: 3697-3703(Dec 1969).

Formulas are presented for describing the transport by molecular flow of gases of nuclides sufficiently short-lived to decay appreciably while moving distances as short as a few centimeters through conventional laboratory apparatus. Special attention is given to the effects of sticking to the walls. (auth) (UK)

Separation Processes

Refer also to abstracts 11416–11418, 11503, 11519, 11549, 11583, 11668, 11764, 11859, 12205, 12348, 13346, and 13562.

11645 (BARC–406) LABORATORY INVESTIGATIONS ON DIRECT CHLORINATION VOLATILITY PROCESSING OF NUCLEAR FUELS. PART IV. SEPARATION OF URANIUM AND PLUTONIUM FROM UO_2–PuO_2 AND PROCESSING IRRADIATED FUEL MATERIALS. Prasad, Rajendra; Rengan, K.; Hariharan, A. V. (Bhabha Atomic Research Centre, Bombay (India)). 1969. 22p. Dep. CFSTI (U. S. Sales Only).

The direct chlorination volatility method for separation of uranium and plutonium from UO_2–PuO_2-type fuel materials was investigated. U_3O_8–PuO_2 mixtures corresponding to oxidized UO_2–PuO_2 fuel compositions were chlorinated at 350 to 450°C using Cl_2–CCl_4 gas. At 350°C, PuO_2 was not converted to chlorides to any appreciable extent, while U_3O_8 formed volatile UCl_5–UCl_4. Refractory fused alumina was used as a high-temperature filter

medium to separate the plutonium and uranium chlorides. Volatile $PuCl_4$ formed in the chlorination reaction decomposed to nonvolatile $PuCl_3$ on Al_2O_3 filter beds at 200°C. The volatile uranium chlorides were absorbed in NaCl sorption beds at 250 to 300°C. The effect of PuO_2 content in $U_3O_8-PuO_2$ mixed oxides on the chlorination volatility separation of plutonium and uranium was studied in the range 1 to 17 wt % PuO_2. The complete processing of irradiated uranium oxide containing PuO_2 by direct chlorination volatility method was investigated briefly in a series of experiments. The final purified uranium fraction had a decontamination factor of 4.7×10^2 (Gross γ), 2.8×10^2 (Gross β), 2×10^3 (Pu), 2.1×10^3 (Zr), 5.1×10^3 (Ce) and 69 (Ru). It is suggested that the plutonium residues from the chlorination volatility processing of UO_2-PuO_2 fuel materials be processed by fluorination methods. (auth)

11646 (BARC–428) PROCESS CHEMISTRY OF NEPTUNIUM. PART I. Srinivasan, N.; Ramaniah, M. V.; Patil, S. K.; Ramakrishna, V. V.; Swarup, Rajendra; Chadha, Ashok (Bhabha Atomic Research Centre, Bombay (India)). 1969. 45p. Dep. CFSTI (U. S. Sales Only).

A brief literature survey on the process chemistry of neptunium was made. Various methods of estimation of neptunium, effects of nitric acid concentration on the distribution coefficients of neptunium(IV) and neptunium(VI) in 30% TBP in Shell sol-T, variation of distribution coefficients of neptunium(IV) and neptunium(VI) as a function of TBP saturation by uranium, and analysis of the Purex Process solutions at different stages for total neptunium content are reported. From the data, it was shown that, under the usual uranium loading of 30% TBP in the Purex Process, both Np(IV) and Np(VI) could be extracted to an appreciable extent, particularly at a nitric acid concentration higher than 2 M, whereas at lower nitric acid concentration very small amounts of Np(IV) may be extracted under the same conditions. Results of the analyses of the Purex Process solutions reveal that during the first extraction cycle neptunium is almost quantitatively co-extracted with uranium and plutonium and in the second extraction cycle neptunium is about 50% extracted. In the third extraction cycle, neptunium is almost completely extracted along with uranium. (auth)

11647 (BARC–430) APPLICATION OF URANOUS NITRATE AS A REDUCTANT FOR THE SEPARATION OF PLUTONIUM FROM URANIUM IN THE PARTITIONING COLUMN. Chitnis, R. T.; Rao, M. K.; Ramanujam, A.; Venkatesan, M.; Gopalakrishnan, V. (Bhabha Atomic Research Centre, Bombay (India)). 1969. 17p. Dep. CFSTI (U. S. Sales Only).

Stripping studies using uranous nitrate as a reductant have been conducted for the separation of plutonium(IV) from uranium(VI) in the concentration range corresponding to the partitioning column conditions in the reprocessing of BWR fuel. Optimum acid conditions and stage requirements for the partitioning column are given. (auth)

11648 (BARC–432) CO-EXTRACTION STUDIES OF URANIUM AND PLUTONIUM WITH TRIBUTYL PHOSPHATE IN NITRIC ACID MEDIA. Srinivasan, N.; Nadkarni, M. N.; Rao, M. K.; Ramanujam, A.; Venkatesan, M.; Gopalakrishnan, V. (Bhabha Atomic Research Centre, Bombay (India)). 1969. 42p. Dep. CFSTI (U. S. Sales Only).

Extraction studies of uranium(VI) and plutonium(IV) utilizing 30% tributyl phosphate–Shell Sol T were conducted in different nitric acid media covering the concentration ranges encountered in reprocessing of BWR fuel. The optimum acid conditions and theoretical stage requirements for the co-extraction of uranium and plutonium from an aqueous solution containing 262 g/l uranium and 1.57 g/l plutonium were determined for uranium loss less than 0.2% and plutonium loss less than 0.1% in the raffinate. (auth)

11649 (CEA-N–1148) SEMIANNUAL REPORT OF THE CHEMISTRY DEPARTMENT NO. 6, JUNE–NOVEMBER 1968. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). June 1969. 424p. (In French). Dep. CFSTI (U. S. Sales Only).

Twelve sections are included; separate abstracts were prepared for each. (P.C.H.)

For abstracts of individual sections see: 11423, 11502, 11650–11658, and 12352.

11650 (CEA-N–1148, pp 81-97) TREATMENT OF MEDIUM AND SLIGHTLY ACTIVE EFFLUENTS. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Developments are reported for studies on: concentration by ion exchangers; chemical treatments by precipitation; evaporation by pulsed air; use of bacteria for effluent treatment; equipment for effluent treatment; recovery of enriched boron; and prototypes and chemical engineering assemblies for effluent treatment. (P.C.H.)

11651 (CEA-N–1148, pp 99-124) REPROCESSING OF URANIUM. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Developments are reported for studies on: treatment of enriched U; new methods for treatment of U; and prototypes and chemical engineering assemblies for treatment of U. (P.C.H.)

11652 (CEA-N–1148, pp 167-80) VARIOUS CHEMICAL STUDIES. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Developments are reported for studies on: use of ion exchange in desalination of seawater; desalting of brackish and seawater by electrodialysis; equipment for desalination of seawater; and use of gas chromatography for preparation purposes. (P.C.H.)

11653 (CEA-N–1148, pp 183-271) STUDY OF PROCESSES FOR REPROCESSING BY AQUEOUS METHODS: LABORATORY. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Developments are reported for studies on: aqueous processing of irradiated fuels based on natural uranium, which includes dissolution after boring of "Sicral" fuels with a graphite core, extraction of Ce(IV) by TBP, extraction of HF by 30% TBP, aqueous processing of "Mosnal" fuel; and effects of sulfates on fluorination of PuO_2; natural and enriched uranium, which includes processing in pulsed columns and centrifuge extractor tests; Pu–Al fuels, which includes processing in diluted TBP and processing diagrams with 30% TBP on irradiated and nonirradiated fuels; experimentation and improvement of AT.1 process in "Cyrano" cell; and extraction of Pu by tridodecylamine diluted in an aromatic hydrocarbide, which includes TBP removal from a TBP–TLA–dodecane mixture and increasing the processing capacity of a Pu purification plant. (P.C.H.)

11654 (CEA-N–1148, pp 273-96) STUDY OF PROCESSES FOR REPROCESSING BY AQUEOUS METHODS: PILOT PLANT. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Developments are reported for studies on: Np recovery on a semi-industrial scale in solutions from the UP_2 plant; and control of a TBP–dodecane solvent–measurement of the TBP percentage in the solvent. (P.C.H.)

11655 (CEA-N–1148, pp 297-334) STUDY OF PROCESSES FOR REPROCESSING BY DRY METHODS. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Developments are reported for: processing of U–Zr and U–Al alloys; and processing of UO_2-PuO_2 fuels in stainless steel cans. (P.C.H.)

11656 (CEA-N–1148, pp 335-68) PREPARATION AND STUDY OF ACTINIDE ELEMENTS. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Developments are reported for studies on: extraction of Np(VI) in presence of nitrous acid by TBP; recovery of ^{237}Np and separation of $^{237}Np-^{239}Pu$ by TLA extraction; Am–Cm separation by extraction of tridodecylammonium nitrate; ^{241}Am recovery from Pu purification effluents; fabrication of Np, Am, and Pu targets for irradiation; fabrication of actinide element sources; preparation of metallic ^{238}Pu for fabrication of sealed sources; and cell for production and study of transuranium elements. (P.C.H.)

11657 (CEA-N–1148, pp 369-93) STUDY OF THE VITRIFICATION OF SOLUTIONS OF FISSION PRODUCTS. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Studies were made on the pot vitrification of solutions from the processing of U–Mo alloy fuels. It was found that the level of activity of the condensate obtained was of the same order of magnitude as that obtained by analogous treatment of solutions of nonalloyed U. Thus it would seem that by using a reflux column and by introducing a larger quantity of sodium hypophosphite in order to reduce the volatility of Ru, the granular filters can be done away with. The equipment used is described. (P.C.H.)

11658 (CEA-N–1148, pp 395-416) FUNDAMENTAL STUDIES. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Developments are reported for studies on: formation of silver double salts in concentrated solutions of cesium and quaternary ammonium halides; properties of heptavalent Np in solution; kinetics of Am(V) reduction by hydrogen peroxide; and effects of organic diluent on Pu(IV) extraction by tridodecylamine in nitric acid solution. (P.C.H.)

11659 (DOCKET-50201-28) [WEST VALLEY REPROCESSING PLANT. Waste Disposal Well No. 1 Data]. (Nuclear Fuel Services, Inc., West Valley, N. Y.). 21 Jan 1970. 10p. Dep. CFSTI.

Information is presented to support a proposal for construction of a deep well for disposal of low-level wastes. Injection test data are given. Specifications for construction of the well are listed. (M.C.G.)

11660 (ORNL-TM-2711) A MATHEMATICAL MODEL AND A COMPUTER PROGRAM FOR ESTIMATING DISTRIBUTION COEFFICIENTS FOR PLUTONIUM, URANIUM, AND NITRIC ACID IN EXTRACTIONS WITH TRI-n-BUTYL PHOSPHATE. Horner, D. E. (Oak Ridge National Lab., Tenn.). Feb 1970. Contract W-7405-eng-26. 27p. Dep. CFSTI.

On the basis of the equilibria involved in the solvent extraction of plutonium, uranium, and nitric acid with tri-n-butyl phosphate (TBP), an empirical mathematical model and a FORTRAN program were developed to allow computer calculation of estimated distribution coefficients. For the 15% TBP system, good agreement was shown between experimentally obtained distribution coefficients that were fitted to the model and the calculated coefficients. (auth)

11661 (RD/B/N-1513) THE BEHAVIOUR OF RADIOACTIVE ISOTOPES IN LIQUID METAL COOLED FAST REACTORS. PART II. AN INVESTIGATION OF ADSORPTION OF Cs AND Ba ISOTOPES FROM SOLUTION IN LIQUID SODIUM. Evans, H. E.; Watson, W. R. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jan 1970. 20p. Dep. CFSTI (U. S. Sales Only).

Adsorption of Cs and Ba isotopes on a variety of materials from sodium was studied in the temperature range 25 to 600°C using a γ-tracer technique. No adsorption of Cs on metal foils was detected and the apparent adsorption of ^{137}Cs reported elsewhere is attributed to adsorption of its metastable daughter nuclide ^{137m}Ba. Adsorption of ^{137}Cs on graphite was confirmed. (auth)

11662 (RFP-1415) PREPARATION OF RADIOCHEMICALLY PURE NEPTUNIUM METAL FOILS. Conner, William V.; Basso, Donald L. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 30 Dec 1969. Contract AT(29-1)-1106. 6p. Dep. CFSTI.

Radiochemically pure neptunium metal was prepared for fabrication into thin metal foils. The neptunium purification was accomplished using nitrate and chloride anion exchange techniques. The procedure used removed all nuclides that emit gamma rays with energies above 1 MeV. In addition, the content of the actinide impurities in the purified metal was reduced to a total of 76 ppM. (auth)

11663 SOLIDIFICATION OF AQUEOUS RADIOACTIVE WASTE CONCENTRATES BY INSERTION IN BITUMEN. Fischer, W. (Institut fuer Kraftwerke, Berlin); Koerner, W. Isotopenpraxis; 5: 376-82(Sep-Oct 1969). (In German).

Insertion of aqueous low-level and medium-level radioactive concentrates (precipitation deposits, distillation concentrates) in bitumen of B 45, B 80, GB 85/25 type was investigated on the laboratory scale by hot insertion and emulsion techniques using model concentrates partially labeled with radioactive isotopes. For a 10 to 20% solid-state content in the aqueous concentrate, bitumen concentrate solids of a maximum of 50% of the solid fraction were obtained with concentration factors of 5 to 2. Leaching rates, gas formation, and change of mechanical properties by gamma-irradiation were studied for considering safety in long-term storage of radioactive bitumen concentrate solids. (auth)

11664 ION EXCHANGE OF A MIXTURE OF Er AND Tm WITH HEDTA. Hagiwara, Zenzi; Oki, Hideo (Tohoku Univ., Sendai). Bull. Chem. Soc. Jap.; 42: 3177-84(Nov 1969).

Under experimental conditions similar to those in the elution system of the rare earth with a dilute HEDTA eluant, the Er–Tm separation factor was found in the system of HEDTA and Dowex 50W, X-8, 50 to 100 mesh. The values for this pair, 1.57 at 25°C and 1.63 at 60°C were in agreement with the values calculated from the stability constants of the rare earth-HEDTA chelates. Further, an equimolar mixture of Er and Tm was eluted with a 0.015M HEDTA solution buffered with ammonium hydroxide. Under the present experimental conditions, the adsorption band of each rare earth reached a steady state after it had moved down through the hydrogen-retaining bed to a distance several times the initial band length. Several series of experimental data were used for analyses of the adsorption band from the point of view of rate theory. It was concluded that the present ion-exchange process with a HEDTA eluant was controlled by film diffusion as the rate-determining step. The plate-height values were also found to be functions of the flow rate. (auth)

11665 THE TREATMENT OF CANADIAN URANIUM ORES: A REVIEW. Gow, W. A.; Ritcey, G. M. (Dept. of Energy, Mines, and Resources, Ottawa). CIM (Can. Mining Met.) Bull.: 62: 1330-9(Dec 1969).

The present state of the art relative to the treatment of Canadian uranium ores and various modifications in the conventional acid–leach flow sheet which make it possible to treat uranium ores of lower grade than have been used in the past are discussed. Only those modifications that have been tested on at least a pilot-plant scale are discussed. It is assumed that the uranium ores that will be mined in the future in Canada will be similar to those already developed. Some of the processes considered are: the concentration of the uranium minerals ahead of leaching by flotation, gravity or electronic sorting techniques; bacterial leaching; and solvent extraction operations for the production of higher purity uranium precipitates and by-products such as rare earths. The assessments of the applicability of these processes are based on technical considerations, approximate net costs of the modified processes, and the effect of the modifications on the characteristics of the waste from the process. (auth) (Canada)

11666 IODINE COLLECTION EFFICIENCY OF ACTIVATED CHARCOAL FROM HANFORD REACTOR CONFINEMENT SYSTEMS. Ludwick, J. D. (Battelle-Northwest, Richland, Wash.). Nucl. Appl. Technol.; 8: 310-13(Mar 1970).

The iodine adsorption characteristics of activated charcoal from the gas confinement systems of nuclear reactors at Hanford were determined. Results from tests conducted under ambient conditions with molecular iodine showed that all reactor charcoals were adequate for continued use. However, at high humidity and temperature, all reactor charcoals exhibited reduction in iodine adsorption of at least 2% and in a few cases the loss was so severe as to warrant charcoal replacement. Under the more severe adsorption conditions, the iodine efficiency range for the nine reactors tested was 82 to 98%. (auth)

11667 EXPERIMENTAL ANALYSIS OF FISSION-GAS HOLDUP BEDS. Underhill, Dwight W. (Harvard Univ., Boston). Nucl. Appl. Technol.; 8: 255-60(Mar 1970).

Exact equations for the experimental analysis of fission-gas holdup beds are developed by the method of statistical moments. The mean retention time, given by the first moment, is independent of the factors which affect mass transfer. This independence emphasizes the important fact, sometimes overlooked in the analysis of fission-gas holdup beds, that the true dynamic adsorption coefficient for a stable fission-gas isotope is identical to the static adsorption coefficient. The second moment, used in combination with the first moment, describes the spreading of the input after it has passed through the holdup bed. The meaning of these equations is examined in detail, and by their correct use the factors needed for the design of fission-gas holdup beds can be determined rapidly from laboratory experiments. This method of analysis is applied to data obtained from fronts of dilute ^{85}Kr passed through charcoal beds. (auth)

11668 PROBLEMS IN NUCLEAR FUEL REPROCESSING. Nippon Genshiryoku Gakkaishi; 11: 632-8(Oct 1969). (In Japanese).

A summary is presented of technical problems in nuclear fuel reprocessing, as discussed by the Special Committee on Nuclear Fuel Reprocessing during the two years from its establishment in April 1967 to its dissolution in March 1969. Problems in solvent extraction, fluoride volatility, aquafluor, and pyrochemical processes are considered along with general problems in reprocessing equipment, materials, and waste disposal. (NSA of Japan)

11669 THE DETERMINATION OF PHOSPHORUS ISOTOPES ^{32}P AND ^{33}P IN THE ATMOSPHERE. 2. ON CLEANING OF ^{32}P AND ^{33}P FROM SOME β-EMITTER ISOTOPES. Shvedov, V. P.; Shopauskene, D. A. (Inst. of Physics and Mathematics, Vilnyus, USSR). Liet. TSR Mokslu Akad. Darbai, Ser. B; No. 3, 115-24(1969). (In Russian).

Conditions for the cleaning of radiophosphorus from β-emitter isotopes such as ^{90}Sr, ^{137}Cs, ^{144}Ce, and ^{106}Ru were studied. It was estimated that the precipitation of ammonium phosphomolybdate is contaminated by the presence of β-emitter isotopes (5 to 10%) in the sample. It was found that precipitation of ammonium phosphomolybdate with precipitation in series $MgNH_4PO_4$ provides full separation of radiophosphorus from other β-emitter isotopes. (auth)

11670 ON THE ENRICHMENT OF THE STABLE ISOTOPE ^{34}S IN THE HYDROGEN SULPHITE–SULPHUR DIOXIDE SYSTEM. PART I. THE $NaHSO_3/SO_2$ SYSTEM. Stiehl, G.; Muehle, K. (Institut fuer Stabile Isotope, Leipzig). Isotopenpraxis; 5: 326-8 (Sep-Oct 1969). (In German).

The composition of the solution and the pH value of the system $NaHSO_3/SO_2$ were investigated, dependent on the $NaHSO_3$ concentration. The dependence of the overall separation factor for the enrichment of ^{34}S on the $NaHSO_3$ concentration, temperature, and flow rate was determined experimentally. The single stage factor for 3 m $NaHSO_3$ was found to be $\alpha = 1.067$. (auth)

11671 SEPARATION FACTOR FOR THE EXTRACTION SYSTEMS YCl_3–$ErCl_3$–HCl, YCl_3–$HoCl_3$–HCl AND SOME LANTHANIDE CHLORIDES–HYDROCHLORIC ACID WITH 1M BIS(2-ETHYLHEXYL) PHOSPHORIC ACID IN n-HEPTANE. Goto, Totaro. Tokyo Kogyo Shikensho Hokoku; 64: 384-9(Oct 1969). (In Japanese).

The distribution coefficients of Y, Er, and Ho and the separation factors of some lanthanides with respect to Y are given at macroconcentrations when the lanthanides are extracted by 1.0M bis(2-ethylhexyl) phosphate (D2EHPA) in n-heptane from their chloride solutions. It was found that the separation of Er and Ho from Y is difficult with D2EHPA. However, the separation factors of Sm, Gd, Dy, and Yb indicate that removal of these lanthanides from Y is rather easy. (auth)

11672 BEHAVIOR OF THORIUM SORPTION ON AMMONIUM MOLYBDOPHOSPHATE. Ganzerli-Valentini, M. T.; Maxia, V.; Barbaro-Forleo, M. (Univ., Pavia, Italy). Radiochem. Radioanal. Lett.; 2: 225-32(27 Dec 1969).

Thorium sorption on ammonium 12-molybdophosphate in nitric and sulfuric acid solutions was studied under static conditions. The results show that Th^{4+} is adsorbed on AMP with an ion-exchange mechanism over a limited region of acid concentration. Outside this range the sorption is complicated by hydrolysis and complex formation. (auth)

11673 ISOLATION OF PLUTONIUM IN CHLORIDE MEDIA. III. EFFECTS OF NITRATE AND MONO (2-ETHYLHEXYL) PHOSPHORIC ACID ON EXCTRACTION WITH DI (2-ETHYLHEXYL) PHOSPHORIC ACID. Chilton, J. M.; Fardy, J. J. (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem.; 31: 3871-4(Dec 1969).

A plutonium isolation scheme involving solvent extraction with the di(2-ethylhexyl) phosphate is used routinely at the Transuranium Processing Facility at Oak Ridge National Lab. The influence of two contaminants, nitrate ion and mono(2-ethylhexyl) phosphate, which are sometimes present in the extraction system, were examined. It was concluded that these contaminants increase the extraction of plutonium but impede its stripping and the monoester acid also impairs intra-actinide separations. (UK)

11674 LIQUID–LIQUID EXTRACTION OF Np(V) USING 1-NITROSO-2-NAPHTHOL AND ITS RADIOCHEMICAL SEPARATION FROM FISSION PRODUCTS. Qaim, S. M.; Hanif, J. (Atomic Energy Centre, Lahore). J. Inorg. Nucl. Chem.; 31: 3886-8(Dec 1969).

The extraction behavior of Np(v) with 1-nitroso-2-naphthol was studied by varying the pH of the solution, the reagent concentration, and the solvent used. The optimum conditions were found to be 0.075 M solution of the reagent in isoamyl alcohol at pH 9.17. Under these optimum conditions the extraction behavior of ^{45}Ca, ^{51}Cr, ^{54}Mn, ^{65}Zn, ^{90}Sr, ^{95}Zr, ^{95}Nb, ^{106}Ru, ^{114}In, ^{137}Cs, ^{147}Pr, ^{175}Hf, ^{182}Ta, ^{192}Ir, ^{207}Bi, ^{210}Pb, and ^{233}Pa was also investigated. A procedure for separation of neptunium from fission products based on the above observations is suggested. (UK)

11675 ON THE TRANSFER MECHANISM OF URANIUM(VI) AND PLUTONIUM(IV) NITRATE IN THE SYSTEM NITRIC ACID–WATER/TRIBUTYLPHOSPHATE–DODECANE. Baumgaertner, F.; Finsterwalder, L. (Univ., Heidelberg). J. Phys. Chem.; 74: 108-12(8 Jan 1970).

Using the single-drop method as experimental technique, the initial transfer rates of uranium(IV) and plutonium(IV) were determined between aqueous nitrate or nitric acid and TBP dissolved in dodecane. The results of kinetic measurements were interpreted in terms of chemical interface reactions. As soon as the metal enters the interface either in ionic or neutral form it is an interfacial complex which adds TBP molecules by degrees from the organic phase as well as nitrate anions from the aqueous phase. No evidence exists of a distinct sequence in the addition of the ligands; that means that the TBP reacts not only with the neutral metal compound but also with the ionic species. The interfacial complexes cannot be distinguished according to the phase they came from. Equilibrium is obtained by a dual transformation of the interfacial complexes either to the organic or to the aqueous phase and not by two reactions running independently in opposite directions. (auth)

11676 DISTRIBUTION EQUILIBRIA OF $PrCl_3$–$NdCl_3$–$SmCl_3$–HCl SYSTEM WITH 1.0M BIS(2-ETHYLHEXYL) PHOSPHORIC ACID IN n-HEPTANE. Goto, Totaro. Tokyo Kogyo Shikensho Hokoku; 64: 377-83(Oct 1969). (In Japanese).

The presence of one lanthanide was found to inhibit or promote the extraction of the other lanthanide present in the two salt extraction systems of $PrCl_3$–$SmCl_3$–HCl and $NdCl_3$–$SmCl_3$–HCl, with 1.0M bis(2-ethylhexyl) phosphate in n-heptane. This mutual interference effect was quantitatively expressed by means of a new parameter. The three salt system of $PrCl_3$–$NdCl_3$–$SmCl_3$–HCl can be reduced virtually to a "two salt" system of (Pr + Nd) Cl_3–$SmCl_3$–HCl and a rough estimation of distribution in equilibrium of this system is possible with the use of the above-mentioned parameters. (auth)

11677 METHOD OF RE-PROCESSING NUCLEAR FUEL OR FERTILE MATERIAL OR NUCLEAR FUEL OR FERTILE ELEMENTS COATED WITH OR CONTAINING GRAPHITE. (to Kernforschungsanlage Julich GmbH). British Patent 1,176,024. 1 Jan 1970. Priority date 23 Apr 1966, Germany.

A method is described for reprocessing nuclear fuels coated with or containing graphite by treatment with alkali metals at 300 to 1000°C to disintegrate the coating and then separation of the fuel or fertile material from the graphite by chemical and/or physical separation. The process may be carried out either in a fluidized bed or in a tubular rotary furnace. (B.L.M.)

11678 DECONTAMINATION PERFORMANCE OF CATION EXCHANGE COLUMNS IN REGENERATIVE OPERATION. Edgerley, Edward Jr. Berkeley, Calif.; Univ. of California (1968). 152p.

Thesis.

A laboratory and field scale study was conducted to develop the interrelationships between ion exchange resin, exchangeable ion, and interfering organic matter. Calcium and trace concentrations of radiostrontium were the metallic ions studied, a dog waste served as the source of organic matter and a high-capacity, strong acid, sulfonated polystyrene divinylbenzene cation exchanger was used as the ion exchange medium. The resin was studied in columnar form and in a regenerative mode of operation. The laboratory study consisted of determining breakthrough concentration histories for three exchange columns, each operating at a different regenerative level, namely 0.6, 1.2 and 1.8, the stoichiometric quantity of regenerant required to completely regenerate the column. Both laboratory and field studies showed detrimental effects to high-order decontamination by the passing of large quantities of organic-laden wastes through an ion exchange column prior to the arrival of the exchangeable ion front. This offsets the advantages of long columns and highly regenerated resins in producing a high-order removal of an exchangeable ion. Interactions between organic matter and the exchangeable ion in an exhaustant liquid result in organic complexing and metallic ion leakage through the ion exchange column. Further, interactions between organic matter and the ion exchange resin result in fouling of the resin and reduction in exchange capacity. Both are adverse to high-order decontamination. Removal of a particular ionic species by ion exchange resin when organic matter is present is accomplished both by ion exchange and by sorption, the latter sometimes being irreversible. (Diss. Abstr.)

11679 ELECTROLYTIC RECOVERY OF METALLIC URANIUM FROM U–Nb ALLOY BY MOLTEN SALT ELECTROLYSIS. Cho, Kangjo; Mochinaga, Junichi (Tokyo Inst. of Tech.). Denki Kagaku; 37: 791-5(Nov 1969). (In Japanese).

The electrolytic recovery of metallic U by molten-salt electrolysis is one method of reprocessing irradiated U fuel from nuclear reactors. In the present study, U–Nb alloys were used for the anode. The electrolysis was carried out using a UCl_3–KCl–NaCl (e.m.) bath in a purified argon atmosphere at 600 to 750°C. The effect of cathodic current efficiencies on the initial current density for the cathode and the UCl_3 content in the bath were observed. After electrolysis, the anode was subjected to electron-probe and visual microanalysis. The decontamination factor for Nb in the U–Nb alloy was about 70 to 700, and satisfactory elimination of other impurities was also achieved. (NSA of Japan)

11680 STUDIES ON ISOTOPE SEPARATION OF LITHIUM BY ELECTROMIGRATION IN FUSED LITHIUM BROMIDE AND POTASSIUM BROMIDE MIXTURE. I. ENRICHMENT OF ^7Li. Yamamura, Yoshinobu (Tohoku Univ., Sendai). J. Nucl. Sci. Technol. (Tokyo); 6: 698-702(Dec 1969).

Lithium-7 was enriched by electromigration at 500°C in a fused LiBr–KBr mixture. The migration cell was made of Pyrex glass; zircon sand was used as a packing material; and graphite rods were used as electrodes. The electromigration was carried out for 13.4 days at constant electric current of 165mA. The distribution of the abundance ratio of Li isotopes and the composition of the

salt in the migration cell were investigated. The abundance ratio of the Li isotopes ($^7Li/^6Li$) in the anode compartment was found to change from the original value of 12.20 to 46.9. The composition (Li/K in chemical equivalent ratio) of the salt reached roughly constant at 1.41 throughout the migration cell except in the vicinity of the cathode, and the value was not effected by the composition of the feed salt. It is the selective transport of salt of this composition toward the anode compartment by capillary action in the migration cell that is considered the mechanism that makes sustained electromigration possible. The mechanism of the accumulation of the isotope effect is also discussed. (auth)

11681 NEPTUNIUM SEPARATION FROM URANIUM. Trevorrow, LeVerne E.; Gerding, Thomas J.; Steindler, Martin J. (to United States Atomic Energy Commission). U. S. Patent 3,482,949. 9 Dec 1969.

NpF_6 is separated from UF_6 by preferentially reducing the NpF_6 with Br_2 to solid NpF_4. (AEC)

11682 LONG-RANGE PROBLEM OF ELIMINATING RADIOACTIVE WASTE OUTFLOW. Raviv, Samuel (Univ., Paris. Nuclear Research Center, Negev, Israel). Ind. At.; 13: No. 11-12, 47-52(1969). (In French).

Economic means of eliminating low-, medium- and high-activity radioactive waste matters are described. The cathodic decontamination method is of special interest. A reduction in the quantity of medium-activity discharges from operations of unsheathing is obtained by a method of drawing the fuel out of its sheath (stainless steel, Zircaloy, aluminum) without dissolution of the sheath. The drawing-out is based on a dissolution that is regularly produced along the sheath/fuel interface. The extent of this dissolution for any given fuel depends on the concentration of nitric acid and on the temperature. A reduction in the volume of high-activity discharges is obtained through a new method of elimination of nitric acid in the form of a gaseous noncorrosive mixture (N_2O and N_2). This elimination can be effectuated at low temperature. It is based on the periodic phenomenon of passivation/activation. The frequency, the duration and the rate of the periodicity, which determine the speed of decomposition of the nitric acid, depend on the nature of the cathode, on the temperature and on the cathodic density of the current. (auth)

11683 METHOD OF DECONTAMINATION OF MEDIA CONTAINING FISSION PRODUCTS. Musikas, Claude (to Commissariat a l'Energie Atomique). British Patent 1,174,477. 17 Dec 1969. Priority date 3 Nov 1966, France.

A method is described for the liquid-liquid extraction of heptavalent fission products from suspensions obtained during chemical processing of irradiated alloys, especially Al–Pu alloys. The method is described with particular reference to Ru. The solution containing the Ru is rendered alkaline by the addition of NaOH, the fission product is oxidized to the heptavalent state by a sodium hypochlorite solution, and the fission product is extracted with a solution of a quaternary ammonium salt (trilaurylammonium chloride) in an inert solvent (CCl_4 or xylene). (B.L.M.)

11684 AN EQUILIBRIUM THEORY FOR RARE-EARTH SEPARATION BY DISPLACEMENT DEVELOPMENT. Helferich, F. (Shell Development Co., Emeryville, Calif.); James, D. B. J. Chromatogr.; 46: 1-28(7 Jan 1970).

A general equilibrium theory of chromatography is applied to the separation of rare earths by displacement development on a cation exchanger. The essential premises are local equilibrium, uniform sorbent properties, plug flow, absence of axial diffusion, stoichiometric exchange, and constant separation factors. Both development of a preadsorbed uniform band with a chelating agent and operation with chelation prior to loading are considered. The theory yields the distances and times required for resolution of any component from any other was well as the mobile-phase and stationary phase compositions at any point and time during development. Application of the theory to the separation of a fifteen-component rare-earth mineral, euxenite, illustrates the method. (auth)

11685 SEPARATION OF NEPTUNIUM, PLUTONIUM, AMERICIUM, AND THORIUM BY ANION EXCHANGE. Cvjeticanin, D.; Ratkovic, S. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). J. Chromatogr.; 46: 326-8(4 Feb 1970).

A study was made of the separation of Np(VI), Th(IV), Pu(IV), and Am(III) by anion exchange from nitric acid solution. The elution of Am(III) from the column was achieved at 7.2 M HNO_3 (5 ml); Np(VI) at 7.2 M HNO_3 (10 ml), Th(IV) at 4.0 M HNO_3, and Pu(IV) at 0.35 M HNO_3. (D.H.M.)

11686 ZIRCONIUM AND HAFNIUM SEPARATION BY LIQUID-LIQUID EXTRACTION WITH HEXONE (METHYL ISOBUTYL KETONE). Otsuka, Takeshi (Nippon Mining Co., Tokyo). Nippon Kogyo Kaishi; 85: 993-9(Dec 1969). (In Japanese).

The procedure for the separation of 99.7% Hf from Zr by solvent extraction using 4-methyl-2-pentanone is described. In the feed preparation step, a Zr concentration of about 1 mole/l and ammonium thiocyanate (NH_4SCN) of 1.2 to 1.3 mole/l gave good results for succeeding extraction steps. For Hf extraction, a thiocyanic acid concentration in hexone of about 2 mole/l is preferred. Flow ratio (solvent/feed) should be about 2, and 15 to 17 extraction stages are required. A solution of 4 N HCl is desirable for stripping Zr. The flow ratio should be about 1/5 and 15 stripping stages are required. H_2SO_4 (6 N) is used for Hf scrubbing. Control of impurities in 4-methyl-2-pentanone after Hf scrubbing is particularly important in order to limit the Hf content to 0.01% or less. A theoretical explanation for the separation, which was made by equilibrium studies on the solvent extraction system, was in good agreement with experimental results. Studies were also made on the effects of extraction atmosphere, temperature, and iron content in order to prevent the decomposition of thiocyanic acid. Special extraction equipment used is described. (TSS) (NSA of Japan)

11687 RECOVERY OF TANTALUM FROM TIN SLAG. Ishihara, Sangyo (Kaisha, Ltd., Kusatsu, Japan). Shin Kinzoku Kogyo; 14: 317-22(Nov 1969). (In Japanese).

A tantalum refinery was constructed in Yokkaichi for supplying tantalum fluoride from tin slag. As a preliminary treatment, impurity elements other than Ta and Nb are removed by means of an electric furnace, and the concentration of Ta is increased about fivefold. For the removal of W, Si, etc, oxidation-roasting, alkali fusion, and water-leaching are used. The separation of Ta and Nb is carried out by a solvent extraction method in which a mechanical stirring tower of the mixer-settler type is used. (TSS) (NSA of Japan)

11688 SEPARATION OF RARE EARTHS. PART XIII. SOLUBILITY SYSTEMS INCLUDING CERIC EARTH CHLORIDES. Brunisholz, G.; Nozari, M. (Univ., Lausanne, Switzerland). Helv. Chim. Acta; 52: 2303-14(10 Dec 1969). (In German).

In aqueous solution, the chlorides of lanthanum, cerium, and praseodymium crystallize as heptahydrates, those of the other rare earth elements as hexahydrates. Therefore, a miscibility gap exists in the solid phases in all systems comprising the two types of chlorides. Five ternary systems and a quaternary one with this behavior were studied. (auth)

11689 EXTRACTION RATE OF URANYL NITRATE INTO A SINGLE DROP OF TCP. Nakashio, Fumiyuki; Kamei, Yoshinobu (Kyushu Univ., Fukuoka). Kagaku Kogaku; 33: 780-6(Aug 1969). (In Japanese).

In the solvent extraction of uranyl nitrate (UN), it was postulated that UN forms a complex between the aqueous phase and organic phase, and the complex dissolves into the organic phase. It is also acceptable that the formation rate is fast as a rule; however, the turbulence at the interface has an effect on the extraction rate. In order to elucidate the effect, the extraction rate through a single drop and a static interface was determined under various conditions, taking UN extraction with TCP (tricresyl phosphate) for an example, and analyzed the experimental data by a simple model based on the theoretical solution of one-dimensional diffusion with interfacial reactions. Diffusion of the extracted complex was a velocity-controlling step during the drop-forming period, the interfacial reaction rate had some effects on the extraction rate during the drop-ascending period, and no effect was noted in extraction from the static interface. (NSA of Japan)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 11548, 11659, 11852, and 11853.

11690 (AEC-tr-7128, pp 214-34) CORRELATIONS BETWEEN RATES OF ENTRY OF ^{90}Sr FROM THE ATMOSPHERE, ITS CONTENT IN SOIL COVER AND QUANTITY OF PRECIPITATION. Pavlotskaya, F. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). Translation of report A-AC-82/G/L-1300.

The effects of atmospheric precipitation on the abundance of fallout ^{90}Sr in soil surface layers were examined. Data on ^{90}Sr deposition and amounts of precipitation, measured at locations on three continents, are presented. It is concluded that dry fallout is responsible for an important addition to the total deposit of radioactive strontium on the ground, that the influence of atmospheric precipitation on the abundance of radioactive fallout must be very carefully evaluated, and that the degree of ^{90}Sr removal from the soil surface by precipitation depends on the intensity of fallout, climatic conditions, physicochemical properties of the soils, and the form of radioactive strontium in fallout and soil. (L.C.L.)

11691 (AEC-tr-7128, pp 254-62) CALCULATION OF THE REDUCTION OF ^{90}Sr CONTENT IN LAKE AND POND WATER AS A RESULT OF BOTTOM ABSORPTION. Prokhorov, V. M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). Translation of report A-AC-82/G/L-1304.

The concentration of soluble radioactive fission products in the fallout on lakes, reservoirs and other stationary bodies of water decreases slowly with time as a result of the absorption of the radioisotopes by the bottom and to a much lesser extent by the biomass. The concentration of the isotopes is different at various depths of the bottom sediment. A method was developed to calculate these changes of the ^{90}Sr concentration in stationary bodies of water as a function of time. It was assumed that the adsorptive ion-exchange kinetics by the soil, although much weaker than adsorption on ion exchangers, follows the same general rules. It was found that with the exception of a short initial period, the adsorption kinetics of ^{90}Sr is controlled by the diffusion rate of this isotope into the bottom sediment. In principle, no equilibrium is established between the water and the bottom; however, the adsorption rate is decreased until the concentration of the isotope appears to remain constant for a certain period. A formula was derived to predict the ^{90}Sr concentration in the water and in the sediment at a given time from the previous concentration. For a sufficiently long period, the concentration decreases inversely with the square root of the time. The removal half-life is not a constant but increases with time. (TTT)

11692 (CALT-767-P-7-45) PROGRESS REPORT, OCTOBER 1, 1969. Epstein, Samuel (California Inst. of Tech., Pasadena. Div. of Geological Sciences). Contract AT(04-3)-767. 21p. Dep. CFSTI.

Studies in geochemistry showed that industrial lead is being washed into the shallow layers of the oceans and into the surface ocean waters at a rapid rate. The usefulness of lead geochronology depends on understanding the geochemistry of the U–Th–Pb system in Earth. Feldspars from Canada and Wyoming were investigated and showed different lead deposition rates. The geochemical stability of U–Th–Pb in zircon was found to be dependent upon the history of the zircon in the rocks. Efforts to understand the D/H ratio distribution in earth materials progressed in the realm of the biological materials from both ancient and recent times. A mass spectrometer was constructed for the determination of the $^{30}Si/^{28}Si$ isotope variations in natural materials. (J.C.W.)

11693 (IA-1190, pp 191-203) GEOHYDROLOGY. (Israel Atomic Energy Commission, Tel Aviv).

Over the past few years a large number of chemical analyses and field observations were carried out on the many mineral and radioactive springs of the Tiberias–Jordan–Dead Sea Rift Valley. The results are given. A remarkable homogeneity was observed in the chemical composition of the dissolved salts. Six hydrogeographical subgroups were defined. A model of marine origin of these mineral waters was proposed and their sulfur cycle worked out in some detail. (auth)

11694 (ORO-672, pp 122-6) DIFFUSION IN NON-IDEAL SYSTEMS. Spalding, G. E. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

Theoretical means of predicting an experimental means of assessing the role of diffusion in transport of fission products through soils were derived and tested. Diffusion coefficients, $\tilde{D}_{Na}$ and $\tilde{D}_{Sr}$, were determined in six different cells. Data are presented in tabular form. The precision of the experimental method was such that the standard error of the mean observed $\tilde{D}_i$ was expected to be about 0.2% of the mean if $\tilde{D}_i$ was constant with time. In no case was the mean observed $\tilde{D}_i$ as much as 15% different from that predicted; the average difference was about 5%. (C.O.)

11695 WELL-LOGGING RESEARCH FOR GEONUCLEAR TECHNOLOGY. Hearst, J. R.; Carlson, R. C. (Univ. of California, Livermore). Nucl. Appl. Technol.: 8: 276-82(Mar 1970).

For engineering applications of underground nuclear explosions it is necessary to know the properties of the material in which the explosion takes place. Many organizations provide measurements of the properties of interest, but their techniques are not always fully suited to the specific needs of Lawrence Radiation Laboratory. Core data are often unavailable or, if available, are not useful. Therefore, a number of systems have been developed at this Laboratory to measure in place and under especially difficult conditions such properties of earth materials as density and acoustic velocity. We have also developed some techniques for increasing the usefulness to us of measurements made by others, generally by providing calibrations more suited to the rock types in which we work. (auth)

11696 OBSERVATION OF NATURALLY OCCURRING ^{36}Cl. Tamers, M. A.; Ronzani, C.; Scharpenseel, H. W. (Univ., Bonn). Atompraxis; 15: 433-7(Nov-Dec 1969). (In German).

Cosmic ray secondary neutron-produced chlorine-36, with a half-life of 308,000 years, is applicable to the dating of Pleistocene events. However, the origin on the earth's surface produces a complication in the interpretations of the observed activities. The dating equation must be written with two ages, that of the exposure time and the time lapsed after removal from the surface, i.e., the decay age. Chlorine-36 is measured using the complete synthesis of silicon tetrachloride and liquid scintillation techniques. Determinations have been made in five samples consisting of ground water salts, soils, and mineral salts. Seawater has been used as the background material. The chlorine-36 concentrations are discussed and applications of the method illustrated. (auth)

11697 CONTENTS OF STRONTIUM AND ^{90}Sr IN SHALLOW-WATER DEPOSITS. Ishibashi, Masayoshi; Ueda, Shunzo (Kanazawa Univ., Japan). Nippon Kaiyo Gakkaishi; 25: 233-8 (Oct 1969). (In Japanese).

The contents of strontium and strontium-90 were studied in the shallow-water deposits from Nanao Bay, Ishikawa Prefecture. To find the relation between strontium content in the deposit and coastal geology, the deposits taken at the several islets around Honshu, Japan, were also examined. The average contents of strontium and strontium-90 in Nanao Bay deposits were 145 ± 47 ppM and 66 ± 12 pCi/kg dry mud respectively. No relation of natural strontium to radioactive strontium-90 in these deposits was found. As to the deposits collected at the several islets around Honshu, Japan, which consisted mainly of detrital sands, the content of strontium have a range of 13 to 394 ppM (average 101 ± 84 ppM). Strontium was more abundant in the deposits collected near islets of tertiary formations than in those of igneous rocks. (NSA of Japan)

11698 SOIL MOISTURE DETERMINATION BY A NEUTRON SCATTERING MOISTURE METER. Toerocek, I. (National Inst. for Agricultural Quality Testing, Budapest). Agrokem. Talajtan; 18: 107-16(Apr 1969). (In Hungarian).

The neutron scattering method of measuring soil moisture was studied. The scattering cross-section of H as compared to that of other elements was the greatest. Thus, fast neutrons were scattered by the H, lost their energy, and consequently were slowed down. The rate of slowing down was proportional to the number of H atoms, that is, to soil moisture. Soil moisture was measured in the field by the neutron scattering moisture meter, and also in the laboratory. Soil samples were taken at 10-cm intervals and the moisture contents of the same layers were also measured by lowering the probe into the auger hole. The diameter of the auger holes was always the same. The calibration graph was constructed and with its aid the moisture content in volume percent could be determined from the meter readings. The calibration graph of

salt affected soils differed from that of non-salt affected soils. The number of slow neutrons was less in the salt affected soils at the same moisture content. This difference was supposedly caused by the Na ions capturing neutrons in salt affected soils. It was established that the moisture meter indicated the moisture content with a ±2.4% accuracy. In 71.5% of the measurements a difference less than 3% was found between the values of the moisture content measured by the moisture meter and in the laboratory. The greatest difference was 6%. A γ scattering device, using ^{60}Co as radiation source was also used for the determination of volume weight. The two devices used a common basic instrument. Volume weight measurements were carried out at 30-cm depth intervals by lowering the probe into the auger hole and compared with laboratory determinations. The accuracy of data measured with the device was ±0.2 g/cm^3 and the standard deviation of data was considerable. It was established that the neutron scattering moisture meter could be employed for rapid field measurements and that its operation was simple. (BBB)

Meteorology

Refer also to abstracts 11489 and 13576.

11699 (AEC-tr-7128, pp 79-111) DEPOSITION OF RADIOACTIVE DUST AND ITS ELIMINATION FROM THE ATMOSPHERE BY PRECIPITATION. Makhonko, K. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). Translation of report A-AC-82/G/L-1262.

Data on the deposition of radioactive dust and its scavenging by precipitation were reviewed. Equations for dry dust deposition without precipitation and for washout of dust by precipitation are presented and explained. Tabulated and graphical data on washout parameters and the deposition of aerosols are given. It is concluded that the overall "dry" deposition of radioactive dust cannot yet be calculated with complete reliability, although some success is being achieved by the study of the scavenging process. (L.C.L.)

11700 (AEC-tr-7128, pp 163-79) FALLOUT LEVELS AND FISSION PRODUCT CONCENTRATION IN SURFACE AIR NEAR MOSCOW FROM 1962-1967. Konstantinov, I. E.; Fedorov, G. A.; Skotnikova, O. G.; Soldaeva, L. S.; Meshchaninova, E. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). Translation of report A-AC-82/G/L-1292.

The fallout levels and concentrations of gamma-radiating products of nuclear explosions in the surface air in the vicinity of Moscow for the period from 1962 to 1967 are presented. Monthly fallout levels of ^{141}Ce, ^{144}Ce, ^{137}Cs, ^{54}Mn, ^{95}Nb plus ^{95}Zr, ^{103}Ru, and ^{106}Rh plus ^{106}Ru are tabulated and plotted. (L.C.L.)

11701 (AEC-tr-7128, pp 263-87) USE OF COSMOGENIC RADIOISOTOPE MIGRATION PATTERNS IN THE STUDY OF THE PROPAGATION OF RADIOACTIVE CONTAMINATION IN THE ATMOSPHERE. Gedeonov, L. I.; Rys'ev, O. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). Translation of report A-AC-82/G/L-1306.

Observations on the distribution of natural or cosmogenic radioisotopes in the atmosphere were studied to obtain information useful for predicting the behavior of artificial radioisotopes in the atmosphere. Data is presented on the concentrations of ^{7}Be, ^{32}P, and ^{35}S in atmospheric aerosol samples collected near Leningrad during 1963 to 1967, and these plus ^{89}Sr fallout levels for 1963 to 1966. Measured data on the fallout levels of these radioisotopes are compared with theoretical estimates, and a curve for percent radioisotopes concentration versus month of year is derived. In a second section, the effects of large-area weather conditions on the concentration of cosmogenic radioisotopes were investigated. A method was found for distinguishing stratospheric replenishment concentrations of cosmogenic radioisotopes in the surface layer of air according to seasonal variations in concentration. Matching of stratospheric replenishments of concentration against synoptic special features makes it possible to assert that altitude cyclones are one of the fundamental causes for the penetration of significant masses of stratospheric air. (L.C.L.)

11702 (AERE-R-6212) RADIOACTIVE FALLOUT IN AIR AND RAIN: RESULTS TO THE MIDDLE OF 1969. Cambray, R. S.; Fisher, E. M.; Brooks, W. L.; Pierson, D. H. (Atomic Energy Research Establishment, Harwell (England)). Nov 1969. 52p. Dep. CFSTI (U. S. Sales Only). UK 7s.

Samples of atmospheric dust and rainwater have been collected from the United Kingdom and elsewhere. Results are presented of analyses of these samples for various fission products and certain other radionuclides. The concentrations of the long-lived fission products ^{137}Cs and ^{90}Sr in air in the United Kingdom were, in the first half of 1969, about 90% of those for the first half of 1968; the deposition and concentration in rainwater were about 75% of those in 1968. The Chinese explosion of 27th December 1968 contributed about 70% of the long-lived activity in the summer of 1969; the remaining 30% was divided between the Chinese explosion of 17th June 1967 and older debris. Measurements in air in the southern hemisphere show that, in mid-1969, about 75% of the long-lived activity was contributed by the French tests held in the South Pacific in 1968. An estimate is made of the world-wide deposition of ^{90}Sr in rain to the end of 1968. The deposition of ^{90}Sr and ^{137}Cs continued to be equal to the loss by radioactive decay of that already deposited. Concentrations of tritium in rainwater are reported for the first time. Radioactive tungsten was detected in the United Kingdom and elsewhere during the last half of December 1968. (auth) (UK)

11703 ^{181}W IN FALLOUT IN FINLAND. Blomqvist, L.; Asikainen, M. (Inst. of Radiation Physics, Helsinki). Nature (London); 225: 58(3 Jan 1970).

An uncommon radionuclide, identified as the activation product ^{181}W (half-life 130 days), was found in air filters between Dec. 15th 1968 and Jan. 12th 1969, and in monthly precipitation samples for Dec. 1968 and Jan. 1969. The maximum concentrations measured were 11.4 Ci/1000m^3 in air and 160 μCi/km^2 in deposition. Radioisotopes of W are not produced in any significant amount in ordinary nuclear tests, but ^{181}W and ^{187}W were reported in the USA after the Project Schooner experiment in Nevada on Dec. 8th 1968, and this was probably the origin of the Helsinki findings. (UK)

11704 RELATIONSHIP BETWEEN THE UNATTACHED FRACTION OF AIRBORNE RaA AND THE CONCENTRATION OF CONDENSATION NUCLEI. Duggan, M. J.; Howell, D. M. (Radiological Protection Service, Belmont, Eng.). Nature (London); 224: 1190-1(20 Dec 1969).

RaA atoms (^{218}Po) formed from the decay of radon may collide with and become attached to condensation nuclei present in the atmosphere, or remain unattached. The fraction (f) of these atoms in the unattached state is of importance in assessing the hazard arising from the inhalation of radon daughter products, and might be expected to depend primarily on the concentration (Z) of condensation nuclei in the atmosphere; but there are other factors likely to influence (f), for example, the charge carried by the nuclei, the rate of change of nuclei concentration and the rate of change of RaA concentration. In addition, losses of unattached RaA atoms by collision with surfaces, such as walls, may be significant. Measurements of (f) and (z) in various atmospheres are described. No attempt was made to measure the other parameters on which (f) might depend. The results are given in graphic form, and the methods of conducting the measurements are described in detail. The first set of measurements was made in open air, followed by a second set at a more rural site, and a third set at a tin mine in Cornwall. The radon concentration was fairly constant throughout the mine measurements at ~700 pCi/l. A final set of measurements was made with an artificial laboratory atmosphere, having an initial radon concentration of about 200 pCi/l. While the experimental results indicate a relationship between (f) and (Z) of the type predicted by the simple forms already referred to, it is clear that any such relationship is only an approximation to the way in which (f) depends on (Z). Measurements of (Z) however do provide a simple method of obtaining a rough estimate of (f). (UK)(TSS)

11705 VARIABILITY OF WIND DIRECTION WITHIN THE UNITED STATES. Singer, Irving A.; Nagle, Constance M. (Brookhaven National Lab., Upton, N. Y.). Nucl. Safety; 11: 34-8(Jan-Feb 1970).

Increased interest in atmospheric diffusion problems has created need for a quantitative measure of the variability of the mean wind direction with time. It has been proposed that the constancy of the wind, defined as the mean vector wind divided by the mean scalar wind ($\bar{V}/\bar{V}$), be used for simple classification purposes. A trigonometric transformation is used to linearize the variation of constancy with the mean angular range of direction. This function, called the steadiness, S, is then computed for various time periods, and by use of extreme-value theory the recurrence intervals of various mean wind-direction ranges can be predicted. This has been done for 34 stations in the United States. Recurrence-interval maps of the steadiness of wind direction within the United States for various time periods are presented that show the interrelation of geographical location and synoptic meteorology with wind-direction persistence. The most persistent wind directions appear at coastal stations, and the least persistent occur in mountainous regions. (auth)

Mineralogy and Exploration

11706 CANADA'S FUTURE IN URANIUM SUPPLY. Williams, R. M. (Dept. of Energy, Mines, and Resources, Ottawa). Can. Mining Met. Bull.; 62: 1340-55(Dec 1969).

The exponential growth of world population makes it clear that a continuing massive growth in total energy demand is inevitable. The rise to prominence of the fossil fuels has occurred in the short span of only two centuries. It has been just 26 years, within recent memory, since the energy stored in the nucleus of the atom was discovered. In the last 10 years, nuclear energy has become a reality and it now contributes a small but significant portion of our total energy production. It is expected that nuclear energy will become increasingly important, so much so that authorities predict that by the end of this century some 20 percent of the world's total energy consumption will be nuclear. In an effort to fully appreciate this growth, and the magnitude of the associated demand for uranium as a nuclear fuel, some of the growth trends which form the basis for these startling projections are examined. The uranium industry reached its peak in 1959, based on a short-lived demand for uranium for military purposes. Following the decline of the industry in the early 1960's, production levels were maintained artificially at appropriate base levels by means of various governmental purchasing programs. The industry is now on the verge of a rapid expansion to meet the demand for nuclear fuel in the 1970's. The industry is examined on a national and world-wide basis, in an attempt to illustrate the capability of Canada's uranium industry to supply a significant portion of the growing world market for uranium. (auth) (Canada)

11707 FRENCH URANIUM POLICY. Mabile, J. (CEA, Paris). Atompraxis; 15: 402-6(Nov-Dec 1969). (In German).

French excavations in France itself and in foreign countries, especially Africa, have made it possible for France to develop mining reserves equal to 10% of the Western world's uranium supply. Beginning in 1974, it will produce more than 4300 tons annually. The CEA and French industry are already in a position to offer uranium concentrates and uranium hexafluoride for sale on the world market. These products are marketed by an economic group, Uranex. In addition, the CEA can offer its services in regard to other stages in the fuel cycle of nuclear power plants, especially for the processing of irradiated fuel elements. (auth)

11708 ON THE ORIGIN OF SEVERAL COMPONENTS WHICH ACCOMPANY URANIUM IN DEPOSITS OF THE SO-CALLED Bi-Co-Ni-Ag-U FORMATION. Barsukov, V. L.; Belyaev, Yu. I.; Sergeeva, N.; Sokolova, N. T. Z. Angew. Geol.; 14: 512-19(Oct 1968). (In German).

Several types of components were defined, including the quartz-calcite-pitchblende veins and the dolomite-baryte veins. Each of the 3 types of mineral-forming stages is characterized by gang changes, noted in macro and micro components. Content and the state of veins and gang changes suggest that there are strictly reciprocal relations between all 3 stages. The formation process of the 3 types of ore veins must be considered in connection with successive migration cycles for individual elements or element groups. The active participation by mafic rock in the hydrothermal process and the resulting complications in the structure of the U containing veins are properties that are not typical for the Erzgebirge deposits. Formation of such deposits in mafic rock as the Bi-Co-Ni-Ag-U formations is due to the deposition of older components by hydrotherms from the exterior in the gangs and of newer components migrating from the mafic stone. (BBB)

Oceanography

11709 (AEC-tr-7128, pp 66-78) DYNAMICS OF ^{90}Sr AND ^{137}Ce ENRICHED WATER MASSES IN THE TROPICAL ZONE OF THE ATLANTIC OCEAN. Khanaichenko, N. K. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). Translated from report A-AC-82/G/L-1254.

Published data on the distribution in ocean water of ^{137}Cs and ^{90}Sr, produced by atomospheric and underwater nuclear tests, were analyzed and used to study oceanic circulation. The ocean area included was limited to the tropical zone of the Atlantic Ocean. It was concluded that: intensive penetration of long-lived radionuclides from the surface to the ocean depth as a result of turbulent exchange can occur in low latitudes to a depth of 300 to 400 m only, although in individual areas, there can be penetration to 800 m; high concentrations at great depths of surface-deposited radioisotopes occurs chiefly in water of advective origin; and the deep penetration of radioisotopes occurs far more rapidly by advection than by vertical exchange through turbulent diffusion. Finally, it should be borne in mind that ^{90}Sr (and to a certain extent ^{137}Cs), which is found in solution in the ocean, is an integral characteristic property of the water, even though introduced from outside. Hence, assuming that it is possible for high concentrations of radionuclides to penetrate directly from the surface to great depths by direct turbulent exchange, then, firstly, a concentration should obviously be observed on the surface of the ocean which is not smaller than that in deep water, and secondly, in that event the possibility of direct turbulent exchange of other characteristics should be accepted. In fact, however, we observe a fairly stable distribution of various characteristics in the depths of the ocean, corresponding to different types of water of advective origin. (L.C.L.)

11710 RESULTS OF THE RADIOACTIVITY INVESTIGATION AT THE PORT-CALL TO YOKOSUKA HARBOR BY U. S. ATOMIC SUBMARINE FLASHER. Genshiryoku Iinkai Geppo; 14: No. 6, 19-23(Jun 1969). (In Japanese).

U. S. atomic submarine Flasher entered Yokosuka Harbor on April 16 and left April 26, 1969— the second port-call by the Flasher at the harbor. This is the 29th port-call by a U. S. atomic submarine on Japan since the first in November 1964 at Sasebo Harbor. Radioactivity investigation concerning this port-call of the Flasher was made prior to the entry at specified areas within the harbor; during entry by chasing the submarine; during the port-call around the submarine and at specified areas in the harbor; during departure; and by checking the overall harbor. Results of the radioactivity investigation are given in tables. (NSA of Japan)

Seismology

Refer also to abstract 11712.

ENGINEERING

Nuclear Explosions

Refer also to abstracts 11695 and 11709.

11711 (NVO–61) PROJECT RULISON: POST-SHOT PLANS AND EVALUATIONS. (Nevada Operations Office (AEC), Las Vegas). Dec 1969. 58p. (PNE-R–13). Dep. CFSTI.

Project Rulison post-shot plans and evaluations are discussed and include physical characteristics of the Rulison cavity; pressure and temperature expected in the cavity; amount, nature, and distribution of radioactivity in the cavity; reentry plan; radioactive species which may be encountered during reentry; public safety considerations arising from release of radioactivity; procedures to assure public safety; and the radiological safety plan. Maximum hypothetical accidents and ecological considerations are discussed in the appendices. (J.C.W.)

11712 (PNE–1010) ANALYSIS OF GROUND MOTIONS AND CLOSE-IN PHYSICAL EFFECTS, GASBUGGY EVENT. Foote, R. Q.; Hays, W. W.; Kiepinger, R. W. (Environmental Research Corp., Alexandria, Va.). 31 Oct 1969. Contract AT(29-2)-1163. 159p. (PNE-G–51). Dep. CFSTI.

Observed ground motions and close-in physical effects and containment data from the Gasbuggy event were processed, analyzed, and compared with pre-shot predictions. Post-shot physical effects and containment data agreed closely with predictions. The peak band-pass filter response of the recorded seismic signals occurred at significantly higher frequencies (2 to 8 Hz) than typically observed at Las Vegas (<1 Hz). An effect of the higher frequency spectral composition of the seismic energy was to cause peak particle vector accelerations to be higher than pre-shot predictions based on NTS data. Amplitude amplification at alluvium stations varied. Peak motions measured inside the San Juan Basin exhibited little azimuthal variation and were higher than on the limited data acquired outside the basin. Structurally, upturned beds along the perimeter of the central portion of the San Juan Basin are thought to have caused a reduction of seismic energy, and, consequently, motions of lower magnitude at stations located outside the basin. Over the 90 km distance range, peak particle vector velocity and peak particle vector acceleration ground motions were caused by body and surface waves, with surface waves having more effect at the distant stations. (auth)

11713 (SC-RR–69-158) EXPLOSION CRATERS WITH FLAT SLOPES IN ALLUVIUM USING TWO-PASS TRIPLE ROWS. Harris, Virgil A. (Sandia Labs., Albuquerque, N. Mex.). Dec 1969. 48p. Dep. CFSTI.

Detonation of triple-row, two-pass arrays using 64-pound charges in Albuquerque alluvium produced craters which scale quite well to similar arrays produced in sand with 1-pound charges by the Nuclear Cratering Group. An 8-pound model of the 64-pound array produced a crater that was similar in its essential characteristics. Sequenced detonation of rows did not produce craters with acceptably flat slopes. (auth)

11714 (UCRL–50743) TYPICAL REQUIREMENTS, STANDARDS, AND PROCEDURES FOR PLOWSHARE NUCLEAR UNDERGROUND ENGINEERING PROJECTS. Cramer, James L.; Peterson, Max G. (California Univ., Livermore. Lawrence Radiation Lab.). 8 Sep 1969. 38p. Dep. CFSTI.

A general description is given of typical operating requirements, standards, and procedures as used by the Lawrence Radiation Laboratory in fielding a Plowshare Project for underground engineering. Only underground engineering applications as opposed to excavation applications are included. The general roles of other agencies involved are briefly described. It is emphasized that the guidelines presented are for single detonation type experiments in a new location, and are not necessarily applicable to a multiple shot program in a well documented location. Certain items of work and equipment that have a direct effect on the success of the program, or are considered critical, are described in detail. (J.C.W.)

11715 USE OF UNDERGROUND NUCLEAR EXPLOSIONS FOR INCREASING YIELD OF OIL AND GAS DEPOSITS. Kedrovskii, O. L.; Manguschev, K. L. Z. Angew. Geol.; 15: 36-9 (1969). (In German).

Principles of the use of nuclear explosions to increase yields of oil and gas from deposits are outlined; minimum permissible depth is calculated, phases are recognized for an experiment (nuclear reaction, hydrodynamic influence, static influence, after-effects of thermal radiation), radius of an explosion cavity is calculated, and results of 13 underground explosions are tabulated. Calculations suggested for approximation of the zone of rock shattering and macro-cleavage were compared with data for 3 explosions. Temperature increases in rock after an explosion and seismic effects are discussed. The problem of radioactive contamination of the air must be met by detailed study of the geology and work regimes of the deposit. More effective use of secondary methods can also be made in conjunction with nuclear explosions. (BBB)

11716 SMALL EARTHQUAKES AND EXPLOSIONS IN WESTERN NORTH AMERICA RECORDED BY NEW HIGH GAIN, LONG PERIOD SEISMOGRAPHS. Molnar, P. (Columiba Univ., New York); Savino, J.; Sykes, L. R.; Liebermann, R. C.; Hade, G.; Pomeroy, P. W. Nature (London); 224: 1268-73(27 Dec 1969).

A description is given of some pronounced differences that have been found in the amplitude spectra of surface waves from small earthquakes and underground nuclear explosions in western North America, as recorded by the new instruments at epicentral distances 30°. For earthquakes and explosions with comparable amplitudes, Rayleigh waves in the period range was in the 20s, the amplitudes at longer periods (40 to 60s) are consistently much larger for earthquakes than for explosions, and this difference would seem to provide another diagnostic aid for distinguishing between the two types of disturbances. Corroborative evidence was also obtained that explosions generate much smaller Rayleigh and Love waves than earthquakes in the period range 15 to 60s. The results indicate that these new instruments could provide a major advance in both the detection of, and discrimination between, earthquakes and underground explosions. The procedure for discrimination is simple, inexpensive, and does not require the use of sophisticated analysis or data processing. Differences in the time function of the source appear to be the most likely explanation for the observed spectral differences. (UK)

Facilities and Equipment

Refer also to abstracts 11760, 12678, 12762, 12768, 12846, 13223, 13262, and 13542.

11717 (AECL–3420) DESIGN PHILOSOPHY AND OPERATING EXPERIENCE WITH THE WNRE HOT CELL FACILITY. Hart, R. G.; Seymour, C. G.; Ryz, M. A. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Oct 1969. 29p. (SM–125/7; CONF-691008–17). Dep. CFSTI (U. S. Sales Only). AECL $1.00.

From Symposium on Radiation Safety Problems in the Design and Operation of Hot Facilities, Saclay, France.

The objectives of radiation safety and operating efficiency often conflict. The key to preventing this conflict is proper design. How both objectives were met in the design of WNRE Hot Cell Facilities is discussed. In detailed design it is extremely important to use as many features as possible that have operated successfully in other facilities. Many irradiation incidents occur as a result of an "improved design" that does not work properly. Proven methods of transferring irradiated fuels, storing highly active samples, disposing of highly active garbage, disposing of liquid wastes, removing and reinstalling experimental equipment, decontaminating highly radioactive cells, and filtering contaminated air are described in some detail. A flaw in the design of the ventilation and ventilation alarm system resulted in one gross release of activity to the air in the operating area. This incident is discussed and the minor alteration required to avoid such an incident is described. Operating efficiency in the metallurgical sample preparation line would be improved with rapid pneumatic or electrical means of transferring small samples. The all-inclusive cost of providing three 10^6 curie cells, three 10^4 curie cells, five 10^3 curie cells and the necessary building and auxiliaries was about $2,200,000 Canadian. Outlets for all services such as air, vacuum, steam, and water, are inside the cells. Operating experience indicates that neither operating efficiency nor radiological safety would be significantly affected if many of these outlets were outside the cell and the services were run into the cells as required through existing access ports. This would lead to a cost saving of about $50,000. (auth)

11718 (AI-AEC–12759) DESCRIPTION OF THE SODIUM FIRES TEST INSTALLATION. Johnson, R. P.; Price, S. R.; Cordy, R. N. (Atomics International, Canoga Park, Calif.). 30 Nov 1969. Contract AT(04-3)-701. 29p. Dep. CFSTI.

The Sodium Fires Test Installation which consists of four basic subsystems including the test vessel, gas mixture system, sodium

storage and transfer, and the effluent control system is described. (W.H.K.)

11719 (APDA–243) DESIGN, DEVELOPMENT, AND EVALUATION OF A CONTINUOUS FLOW SODIUM CENTRIFUGE. Matte III, Joseph; Toth, William L. (Atomic Power Development Associates, Inc., Detroit, Mich.). Dec 1969. Contract AT(11-1)-865. 110p. Dep. CFSTI.

A program to build a centrifuge for sodium service and to determine its capabilities for continuous removal of particulate impurities from liquid sodium has been undertaken. This unit operates in an argon atmosphere within a spherical glove box. The centrifuge exerts a centrifugal force of 62,000 g at the bowl wall and can process sodium at 300 to 700 F. The centrifuge was connected to a branch of the Sodium Technology Loop through a piping system that regulated the sodium temperature and flow rate. The concentration of impurities in the sodium was controlled in the Sodium Technology Loop. The quantity and type of impurities removed by the centrifuge were analyzed in the sodium chemistry laboratory. In the development of the centrifuge, unusual problems were encountered with bearings and seals capable of rotating at 50,000 rpm in an environment of inert gas. A considerable amount of testing was performed to develop a stabilizing bearing for the bottom of the bowl that had to operate where liquid or a mist of sodium would be present. Another problem was the development of a gas seal that would allow the use of an air turbine mounted external to the glove box, to drive the bowl within the box. An initial 20-hr test established the purification feasibility and capability. The centrifuge was operated at 50,000 rpm (developing 62,000 g) with a sodium flow rate of $\frac{1}{4}$ gpm at 350 F. Although certain minor problems were encountered in the test, the overall performance of the centrifuge system was satisfactory. Another test of 93-hr duration successfully demonstrated the mechanical performance of the centrifuge and the associated loop equipment. The analysis of scrapings of particulate from the bowl showed high concentrations of metallics (iron, nickel, and chromium) and carbon. The concentration of carbon is believed to constitute 30 to 50% of the scrapings. (auth)

11720 (BNL–50173) TOTAL-ELECTRIC SERVICE FEASIBILITY STUDY. Hansteen, Henry B. (Brookhaven National Lab., Upton, N. Y.). May 1969. 26p. Dep. CFSTI.

The results are presented of an extended study of building service facilities on the Brookhaven site as related to the feasibility of total-electric service for future building programs and for more immediate installations which would otherwise require significant extensions of the steam distribution system. The results are presented briefly in the form of recommendations and conclusions and substantiated by detailed studies included as referenced appendices. Specifically, these findings present conclusive evidence favoring the adoption of total-electric building service design criteria, particularly when considered in conjunction with integrated environmental comfort systems. The preparation of these studies has also resulted in the compilation of much relevant data on the operations of the Plant Engineering and Planning Division. (auth)

11721 (CEA-CONF–1423) DISASSEMBLING-UNCOUPLING-REMOVAL OF A LARGE-CAPACITY FURNACE FOR MELTING PLUTONIUM. Boisson, H. (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). [nd]. 31p. (In French). (SM-125/14; CONF-691008-5). Dep. CFSTI (U. S. Sales Only).

From Symposium on Radiation Safety Problems in the Design and Operation of "Hot" Facilities, Saclay, France.

Techniques used for the dismantling, cutting, and disposal of a large capacity plutonium melting furnace are described. The furnace Baobab of considerable size and weight was confined in a glove box with a surface area of 12 m^2 and a 36 m^3 volume. The weight of the whole was approximately 6 tons. The operation was accomplished in the following way. The initial cell was separated into 2 parts by mounting a tight bulkhead around Baobab and its glove box. The large glove box was divided in three areas: a locker room allowing access to furnace with tight protective suits; a furnace cell where dismantling and cutting of furnace and glove box components were carried out with an arc torch and the metallic pieces were given a preliminary treatment; and a processing cell containing a hopper for the transfer of metallic pieces from the furnace cell and the equipment for their disposal into drums. The glove box, mounted around Baobab was equipped with all the necessary devices for the protection of personnel: viewing ports, filtered ventilation, connection of liquid wastes to active tanks, negative pressure and considerable room air change, permanent radio link between the operators wearing protective suits and the outside, and fire safety. During the seven months of the operation no working accident or internal or external body contamination occurred. The advantage of the operation was to show that a safe dismantling of bulky metallic pieces by electric arc cutting rods is possible in tight protective suits by taking all the necessary precautionary measures. (auth)

11722 (ORNL-NSIC–65) DESIGN, CONSTRUCTION, AND TESTING OF HIGH-EFFICIENCY AIR FILTRATION SYSTEMS FOR NUCLEAR APPLICATION. Burchsted, C. A.; Fuller, A. B. (Oak Ridge National Lab., Tenn.). Jan 1970. Contract W-7405-eng-26. 196p. Dep. CFSTI.

A handbook is presented on the design, construction, and testing of very high-efficiency air-cleaning systems with the emphasis on contaminated exhaust air cleaning systems for nuclear plants, laboratories, reactor installations, and other facilities in which radioactive materials are handled. Detailed information is given on operational procedures, environmental factors, emergency requirements, maintenance, cost, and the types of mechanical equipment necessary. The last includes the ventilating system with its ducts, fans, controls, and instrumentation and the various filter systems with their components. The design, construction, and performance of high-efficiency filters, building supply air filter, activated-carbon absorbers, and moisture separators are discussed. Filtration systems for enclosures, particularly glove boxes, are presented. Finally, remotely maintained and reactor postaccident cleanup filtration systems are described. (L.C.L.)

11723 (RFP–1413) COMPUTERIZED PREPARATION OF CALIBRATION SCALES; AN EXPANSION OF PROCESS VESSEL VOLUME CALIBRATION TECHNIQUES. Doher, Louis W. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 21 Nov 1969. Contract AT(29-1)-1106. 23p. Dep. CFSTI.

An expansion of the process vessel calibration technique is described. In the calibration procedure, experimental data are obtained by successively adding known volumes of a calibrating liquid to a vessel. A digital computer then calculates a calibration curve for each process vessel and prints out the certificate. A portion of the computer program tests the data for both systematic and random experimental errors, and accepts or rejects the calibration depending on the magnitude of those errors. In the described expansion, the computer also instructs a plotter to scribe an aluminum "calibration scale" from the calculated curve. (auth)

11724 (WARD–3762-6) DRIVE STUDY FOR THE LOW-CAPACITY SODIUM PUMP. Edwards, R. F.; Matsko, R. M. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Apr 1969. Contract AT(30-1)-3762. 34p. Dep. CFSTI.

Data on the initial and operating costs, the advantages and disadvantages, and the reliability of several liquid-metal pump drive systems that are capable of providing an adjustable speed range of up to 10:1 are presented. The systems investigated were: wound rotor induction motor with a liquid rheostat and a liquid cooled brake, or a liquid rheostat and an air-cooled generator brake, or a solid state static frequency converter; a direct current motor with a solid-state power supply; and motors with electric couplings including a synchronous motor with an electric coupling and a squirrel-cage induction motor with an electric coupling. A system that employs a wound rotor induction motor with a liquid rheostat and air-cooled generator brake is recommended. This recommendation is based upon equipment cost and proven degree of reliability. (auth)

11725 (WARD–3762-7) DYNAMICS SIDE STUDY FOR THE LOW-CAPACITY SODIUM PUMP. Geiger, T. L. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). May 1969. Contract AT(30-1)-3762. 79p. Dep. CFSTI.

More than 200 centrifugal pump shafts were designed and analyzed for critical speed to assess their value as a primary sodium pump. Supporting members, including the pump motor, all bearings, support structure, and pump tank were analyzed for their contributions to the dynamic response of the pump system. Shaft lengths of 24 feet, 30 feet and 40 feet were considered operating at speeds of 900 rpm, 1050 rpm, and 1150 rpm. At 1150 rpm, two 24-foot shaft systems were found to be superior from the standpoint of cost and reliability. (auth)

11726 SELF REGENERATING STORAGE BATTERY. Silver, Gary L. (to U. S. Atomic Energy Commission). U. S. Patent 3,492,160. 27 Jan 1970.

A self recharging radioactive voltaic battery comprising an anodic cell having low valence plutonium ions for oxidation dissolved in an acid solution, a cathodic cell having plutonium ions of a higher valence for reduction dissolved in a more concentrated acid solution, and means for providing ion migration between the anodic and cathodic cells is described. On open circuit conditions the anodic cell regenerates the low valence plutonium ions and the cathodic cell regenerates plutonium ions having the higher valence. (Offic. Gaz.)

11727 CIVIL ENGINEERING WORKS IN THE TSURUGA ATOMIC POWER STATION OF JAPAN ATOMIC POWER COMPANY. Manabe, Kyohei; Kajiyama, Yoshio (Japan Atomic Power Co., Tsuruga). Hatsuden Suiryoku; No. 101, 35-60(Jul 1969). (In Japanese).

The Tsuruga atomic power station of JAPC, under construction at present, is at the end of Tsuruga Peninsula, projecting in the Tsuruga Bay, the area is 1,400,000 m^2, surrounded by mountains. Main features of the atomic power station are: electric output, 322,000 kW; BWR, 967,000 kW, with Zircaloy-clad fuel assemblies of UO_2 pellets of about 2 wt % enrichment, and B_4C control rods; turbine type, double-current exhaust non-reheating; and reactor containment, pressure suppression. Civil engineering works in the Tsuruga atomic power station described include an outline of the atomic power station, leveling of the site and the foundation works, water intake works for the steam condenser, city-water works, works for the pier, and other civil engineering works. (NSA of Japan)

11728 RADIATION-DIAPHRAGM DEVICE. Machiyama, Yoshihiko (to Mitsubishi Heavy Industries, Ltd.). Japanese Patent 1969-23538. 4 Oct 1969. Filed 19 Oct 1966.

The radiation diaphragm device proposed, which is for regulating the shape of irradiation field in radiation therapy for example, has the following advantage. In forming the passage of radiation of a given shape, i.e., an irradiation field of specific shape, two piles of adjoining and parallel shielding blocks are arranged as usual, and this arrangement can be obtained securely, when the array of blocks is in any direction, regardless of the posture of irradiation. Furthermore, the arrangement is simple and easy. Each shielding block consists of the following: the support, which can move the block itself, and which has unevenness such as a rack; a pawl device to stop the block movement by engaging it with the unevenness, and which is mounted on the block; a handle, also mounted on the block, to operate the pawl device; and the shielding block proper. (NSA of Japan)

Heat Transfer and Fluid Flow

Refer also to abstracts 11743, 12453, 12478, 13548, and 13592.

11729 (CEA-R-3892) STRUCTURE OF TWO-PHASE AIR-WATER FLOWS. STUDY OF AVERAGE VOID FRACTION AND FLOW PATTERNS. Roumy, Robert (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Dec 1969. 63p. (In French). Dep. CFSTI (U. S. Sales Only).

Experimental work on a two-phase air-water mixture in vertical tubes of different diameters is described. The average void fraction was measured in a 2 meter long test section by means of quick-closing valves. Using resistive probes and photographic techniques, the flow patterns were determined and diagrams developed to indicate the boundaries between the various patterns: independent bubbles, agglomerated bubbles, slugs, semi-annular, and annular. In the case of bubble flow and slug flow, it is shown that the relationship between the average void fraction and the superficial velocities of the phases is given by: $V_{sg} = f(\langle\alpha\rangle) \cdot g(V_{sl})$. The function $g(V_{sl})$ for the case of independent bubbles has been found to be: $g(V_{sl}) = V_{sl} + 20$. For semi-annular and annular flow conditions, it appears that the average void fraction depends, to a first approximation, only on the ratio V_{sg}/V_{sl}. (auth)

11730 (GEAP-10052) TURBULENT HEAT TRANSFER IN A ROD BUNDLE WITH LIQUID METAL COOLANT. Bender, D. J.; Magee, P. M. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Jul 1969. Contract AT(04-3)-189. 102p. Dep. CFSTI.

The coupled heat transfer equations in the fuel, gap, cladding, and coolant were solved for a triangular-spaced, close-packed fuel rod bundle with liquid metal coolant. The model includes temperature-dependent material properties, turbulent velocity distribution in the coolant, and contributions to coolant heat transfer by turbulent mixing. The model was programmed as a digital computer code and used in a parametric study to determine the heat transfer characteristics for this geometry as a function of Peclet number, pitch-to-diameter ratio, and linear pin power. (auth)

11731 (RD/B/N-1497) EFFECT OF DIFFERENTIAL HEAT TRANSFER COEFFICIENTS ON THERMAL STRESSES IN A NOZZLE SPHERE INTERSECTION. Chubb, E. J. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jan 1970. 15p. Dep. CFSTI (U. S. Sales Only).

Spatial variations of surface heat transfer coefficient frequently occur in power plant components. These variations are thought to cause high thermal stresses. A particular aspect of the problem was investigated to establish the increases that may arise in one typical shape for reasonable variations in heat transfer coefficient. The component chosen was a relatively thick cylinder to sphere intersection. (auth)

Isotope Technology

Refer also to abstracts 11476, 11548, 11726, 11751, 12176, 12805, and 13245.

11732 (CNEA-221) STUDY OF THE DOSE DISTRIBUTION PRODUCED BY A PLANE ^{60}Co SOURCE AND COMPARATIVE ANALYSIS OF THE YIELD. Gonzalez, Ruben O. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1968. 14p. (In Spanish). Dep. CFSTI (U. S. Sales Only).

The results of a theoretical study made with the object of assisting in the design of the irradiation plant that the Gerencia de Energía proposes to construct in the Centro Atómico Ezeiza are reported. The variation of the dose of a rectangular source was analyzed by kinetic irradiation of the blank when the thickness of the blank and the distance between it and the source were modified, with one and two passes of the blank for each side of the source. A method is given for the theoretical calculation of the exposure in air. The dose distribution in a water medium for distinct air thicknesses interposed between the source and the blank was studied. (tr-auth)

11733 (IA-1190, pp 205-16) APPLICATIONS OF TRACER TECHNIQUES. (Israel Atomic Energy Commission, Tel Aviv).

The investigation of seawater pollution with the aid of radioisotope tracers is described. Dilution and residence time of waste water discharged into the sea were measured and used for the determination of the rate of inactivation of bacteria. Sand movement on the sea floor was investigated along the coast of Israel and in the port of Rio de Janeiro, Brazil. Flowmeter calibration was done for various customers, and ventilation studies were carried out in a greenhouse complex. (auth)

11734 (IEA-159) PRODUCTION OF RADIOISOTOPES IN THE DIVISION OF RADIOCHEMISTRY OF THE ATOMIC ENERGY INSTITUTE. Goncalves da Silva, Constancia Pagano (Instituto de Energia Atomica, Sao Paulo (Brazil)). Jun 1968. 21p. (In Portuguese). (CONF-680423-4). Dep. CFSTI (U. S. Sales Only).

From 2nd Inter-American Conference on Radiochemistry, Mexico City, Mex.

The present work examines the aspects relative to the development of research bearing on the present stage of production of radioelements in the Division of Radiochemistry of the Institute of Atomic Energy. Some time considerations show the reasons for the selection of the isotopes presently produced and distributed. The characteristics of the material distributed, as for example, the degree of purity were discussed. (tr-auth)

11735 (JAERI-5023) ANNUAL REPORT OF DIVISION OF RADIOISOTOPE PRODUCTION, APRIL 1968-MARCH 1969. (Japan Atomic Energy Research Inst., Tokai). Jul 1969. 77p. (In Japanese). Dep. CFSTI (U. S. Sales Only).

The most important achievement in 1968 was the starting of the scheduled shipment of products. This program had been formulated by properly combining the radioisotope production schedule with the reactor operation schedule, and the attempt of the irradiation with a foreign reactor had been introduced during the scheduled shut-down periods of JRR-2 and JRR-3. New items added were ^{64}Cu, ^{82}Br, ^{124}Sb, ^{134}Cs, and ^{134}Cs. Copper-64 was the most unique item produced with the originally developed method using the Szilard-Chalmers effect. It was also guaranteed by the medical people that the quality of this product could meet the specifications demanded for medical use. The amount of radioactivity shipped in the first quarter was 1.65 times that for the corresponding period of the preceding year. Much progress is reported in research and technical development works. The technical development work for the production of short-lived radioisotopes from fission products had been started. A part of the results obtained in the international joint project with Tsin Hua University was presented to the IAEA Study Group Meeting at Manila in March 1969. The structure for safety control in Radioisotope Production Laboratory was investigated in order to improve its effectiveness, and the safety guides for the works in the laboratory were established. (NSA of Japan)

11736 (NP-tr-1869) TECHNICAL PERFORMANCE OF, AND ECONOMIC CONDITIONS FOR GAS CENTRIFUGAL SEPARATION. Comparison with Gas Diffusion Method. Kanagawa, Akira. Translated from Genshiryoku Kogyo; 14: No. 11, 49-54(Nov 1968). 14p. Dep. CFSTI (U. S. Sales Only).

The economic feasibility of a gas centrifuge for the enrichment of uranium is examined. Its separative ability, power requirements, and construction costs are compared with those for the gaseous diffusion method. (L.C.L.)

11737 LARGE SHIELDED SOURCE IRRADIATOR (4 Aug 1969) (Engineering Materials). (Edgerton, Germeshausen and Grier, Inc., Santa Barbara, Calif.). (CAPE-1943).

9 drawings.

An irradiation system, which is used in investigating the ecological effects of ionizing radiation on plants and small-animal populations and provides uniform dose rates over relatively large land areas, is described. Sources are mounted on thin poles and source shielding is arranged to control close-in dose rate. The source consists of a stainless steel shell 3.906 in. long, 4.750 in. OD, and 3.125 in. ID filled with 31,500 Ci of ^{137}Ce. The other source consists of 66,000 Ci of ^{137}Ce distributed in 56 in.^{2} in a 4.125 in. long stainless steel shell with an OD of 5.500 in. and an ID of 3.625 in. The main shield is fabricated of Pb and the secondary shield of Al alloy. (For details see TID-4100, Suppl. 56.) (F.S.)

11738 RADIOACTIVE ISOTOPES. Coe, Gordon R. (Univ. of Southern Mississippi, Hattiesburg). pp 373-428 of Characterization of Coatings: Physical Techniques. Part I. /Myers, Raymond R. (ed.). New York; Marcel Dekker, Inc. (1969).

Fundamental concepts of naturally occurring and induced radioactivity are reviewed. Various methods of radiation detection and the application of radiochemical techniques to the measurement of physical properties, reaction mechanisms, and miscellaneous properties of films and coatings are discussed. Other topics treated are radiation effects on organic coatings, activation analysis, licensing requirements, and health physics. (J.G.B.)

11739 FLEXIBLE SEALED ^{90}Sr–^{90}Y SOURCES FOR LARGE AREA SKIN IRRADIATIONS. Bell, M. C. (UT-AEC Agricultural Lab., Oak Ridge, Tenn.). Int. J. Appl. Radiat. Isotop.; 21: 42-3(Jan 1979).

Beta irradiation sources using ^{90}Sr–^{90}Y were made for use on the backs of sheep over several days without restricting the free movement of the animals. The design and the calibration of the sources by glass rod dosimeters, are described. The measured dose-rate at the surface was between 913 and 1570 rad/hr. (UK)

11740 ISOTOPES AND RADIATION TECHNOLOGY. VOLUME 7, NUMBER 3. Baker, P. S.; Lafferty, Robert H. Jr.; Gerrard, Martha; Greene, R. E.; McKinney,, F. E.; Miller, F. J.; Hess, D. N. (eds.). One of Four Quarterly Technical Progress Reviews Published for the Division of Technical Information, USAEC. Oak Ridge, Tenn.; Oak Ridge National Lab. (Spring 1970). 115p. GPO $0.70.

Separate abstracts were prepared for the 12 papers presented. (W.H.K.)

For abstracts of individual papers see: 11495, 11628, 11741–11744, 11751–11753, 11775, 11853, 11854, and 12119–12129.

11741 FORSEEABLE APPLICATION OF ^{252}Cf TO NEUTRON RADIOGRAPHY. Barton, J. P. (Argonne National Lab., Ill.). Isotop. Radiat. Technol.; 7: 285-91(Spring 1970).

The foreseeable future demand for ^{252}Cf as a neutron source for neutron radiography is analyzed in the light of the present rapid growth of application work in this field. (auth)

11742 SURVEY OF APPLICATIONS FOR ^{252}Cf. Crandall, J. L. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Isotop. Radiat. Technol.; 7: 306-18(Spring 1970).

One gram of ^{252}Cf emits 2.34×10^{12} n/sec from a volume of less than 1 cm^3 with a heat production of less than 40 watts and a half-life (alpha + spontaneous fission) of 2.6 years. Because of its high average neutron yield per radioactive disintegration, it produces neutrons less expensively than any comparable radioisotope source and competitively with small nuclear reactors and accelerators. It thus has major potential in providing compact, portable, and reproducible neutron sources at intensities ranging from a few up to 10^{14} n/sec. Such sources have unique applications as tissue implants for cancer therapy, as point sources for neutron radiography, and as portable tools for mineral exploration and also fill more specialized needs, e.g., for making reactor physics measurements. Other uses are expected in such fields as activation analysis, short-lived radioisotope production, moisture gages, well logging, and in-line process instrumentation, where the operating simplicity, minimal maintenance, and fully predictable output of these sources should open many applications currently closed to the more conventional accelerator and reactor sources. Particular emphasis is being placed on industrial uses of the ^{252}Cf sources for in-line process control. A preliminary market survey by Savannah River of possible ^{252}Cf applications indicates a demand for 20 to 60 g of ^{252}Cf by 1975 with the probability of an exponentially increasing demand for some time thereafter. (auth)

11743 DISCHARGE MEASUREMENTS USING RADIOISOTOPES IN HIGH-HEAD TURBINES AND PUMPS. Hansen, R. L. (Bureau of Reclamation, Denver). Isotop. Radiat. Technol.; 7: 330-3(Spring 1970).

A method, using ^{82}Br, being developed for measuring flow rates in high-head turbines and pumps was tested on a 6000-ft-long, 6-ft-diameter penstock and a 6000-ft-long, 8-ft-diameter pump discharge line. The data obtained were less precise than desired but were encouraging and indicated pipe lengths required for natural turbulence to mix pipe flow and tracer and for additional mixing induced by a pump. (auth)

11744 SOME POTENTIAL USES OF RADIOISOTOPES FOR SECURITY AND LAW ENFORCEMENT. Wing, James (National Bureau of Standards, Washington, D. C.). Isotop. Radiat. Technol.; 7: 334-40(Spring 1970).

The results of feasibility studies on several applications of radioisotopes for security and law enforcement are reported. Techniques and systems have been developed for secret marking of equipment with radioactive screws, invisible labeling and storing of secret information by recoiled radioisotopes, treating hydrogenous surfaces with tritium for positive identification, safe-locking by radioisotope keys and gamma-ray spectrometry, and detecting door intrusion by gamma-ray spectrometric monitors. The advantages and limitations of each potential use are discussed. (auth)

11745 COMPTON SCATTERER AS SOURCE OF MONOENERGETIC GAMMA RAYS. De Beer, G. P. (Atomic Energy Board, Pretoria). Nucl. Instrum. Methods; 78: 13-18(1970).

A Compton scattering unit which scatters a relatively high proportion of photons from a point source through a single angle, is described. The efficiency with which photons from a ^{137}Cs source are scattered is given, together with the energy spread of the scattered photons. These characteristics are extrapolated to other photon energies and scattering angles. Suggestions towards optimizing such a scatterer are given. (auth)

11746 A GAS-PHASE ^{85}Kr BETA EXCITED X-RAY SOURCE. Artman, C.; Preuss, L. E. (Edsel B. Ford Inst. for Medical Research, Detroit). Nucl. Instrum. Methods; 78: 319-20(1970).

Studies were made of beta-excited x-ray sources utilizing ^{85}Kr, in the gaseous form, and Cu foil target. The gas phase necessitated the construction of a special source holder. An example of the spectrum produced, as detected by an argon-methane flow counter, exhibits the classical form, with a well defined K_α doublet and the white radiation continuum. Comparison of ^{85}Kr to ^{204}Tl, a non-gaseous emitter of similar beta E_{max}, indicates the ^{85}Kr source, as constructed, to be approximately 10 times less efficient than ^{204}Tl in K x-ray production. This difference in efficiency is probably due to the variation in source geometry, as ^{204}Tl–Cu has 5 mil Cu backing and ^{85}Kr–Cu has no backing target. The K photon to total photon ratio is 0.33 for ^{85}Kr–Cu vs 0.69 for ^{204}Tl–Cu with 1.2 mil Cu and 1.3 mil Cu respectively. Such a noble gas, beta-excited source of stimulated x-rays provides a photon source uniquely safe, in the event of rupture of the seal. (auth)

Materials Testing

Refer also to abstracts 11738, 11823, 12349, 12356, 12369, 12392, 12403, 12450, 12451, and 13541.

11747 (BNWL-1223, pp 8.1-19) NONDESTRUCTIVE TESTING. Dau, G. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Typical eddy current test signals from a two-frequency tube tester were studied as an aid in the development of a digital computer method for the separation of test variables. The results of this study will provide faster and more accurate means to analyze more test variables at an increased number of test frequencies. A new thermal transducer system has been developed which has high speed capability. The transducer has been tested on several types of specimens; however, some modification will be necessary for real time processing. This system should enable better interpretation of the thermal image and lead to automated data acquisition. A critical angle untrasonic reflectivity technique has been applied successfully to the measurement of cold work and grain size in FFTF fuel pin cladding. A resolution approaching ±2% of cold work was achieved. The method requires more development. A Mössbauer backscatter system has been developed capable of over 130% peak signal to nonresonant background measurements.

This was achieved using special shielding techniques and the latest available equipment. Mössbauer spectroscopy can be performed in the order of minutes using "as is" specimens. (auth)

11748 (GA-9673) PRESSURE AND TEMPERATURE TESTS AND EVALUATION OF A MODEL PRESTRESSED CONCRETE PRESSURE VESSEL. Northup, T. E. (Gulf General Atomic, Inc., San Diego, Calif.). 15 Sep 1969. Contract AT(04-3)-633. 46p. (CONF-691112-1). Dep. CFSTI.

From 2nd Conference on Prestressed Concrete Reactor Vessels and their Thermal Insulation.

A small prestressed concrete pressure vessel (PCRV) was designed, constructed, and tested to provide insight into the predictability of vessel behavior under combined loadings. The model program was conducted to provide a basis for the first U. S. PCRV, now under construction. The model objectives related to construction, short-term response to pressure loads, concrete moisture loss rate, pressure cycle effects, vessel concrete creep at temperature, gross gas leakage, and overpressure were all met, thereby demonstrating that the design, construction, instrumentation, and evaluation and analysis methods used were quite adequate for use on larger similar vessels. The vessel response to prestress, pressure, and temperature was predictable with reasonable accuracy, and it was demonstrated that the vessel could withstand significant overpressure and gross gas leakage without structural distress. (auth)

11749 MEASUREMENT OF CARBON COATING THICKNESS ON MICROSPHERES OF NUCLEAR FUELS. Foster, B. E.; Snyder, S. D. (Oak Ridge National Lab., Tenn.). Mater. Eval.; 28: 13-16(Jan 1970).

An in-line process monitor was developed to determine the average carbon coating thickness on a small batch of thorium oxide microspheres. The method utilizes x ray attenuation. The equipment includes a ^{147}Pm radiation source, NaI(Tl)-photomultiplier detector combination, containment cell for the microspheres, mechanical scanner, and signal-processing instrumentation. Very little of the 38-keV gamma radiation was transmitted through the dense microspheres. Most of the radiation passed tangentially through the carbon coating that effectively separated the microspheres in the containment cell. As the coating thickness increased there was a further separation of the microspheres with an accompanying increase in transmitted radiation through the cell of microspheres. The transmitted radiation was monitored and the resultant signal displayed on a digital voltmeter. (auth)

11750 RADIOACTIVE GAS PENETRANTS FOR NONDESTRUCTIVE TEST INSPECTIONS. Eddy, William C. Jr. (Industrial Nucleonics Corp., Columbus, Ohio). Sci. Advan. Mater. Process Eng. Proc.; 15: 905-12(1969).

From 15th National SAMPE Symposium and Exhibition, Los Angeles, Calif. See CONF-690436.

The use of radioactive krypton as a gaseous penetrant has produced an extremely sensitive flaw detection system. Because of the extremely small size of the gas atom, it can be diffused into material surface irregularities which have heretofore been too small to allow the use of conventional penetrants. The gas also tends to accumulate in areas of high dislocation density, porosity, and contaminants, making these conditions visible against more homogenous material. (auth)

11751 EVALUATION OF CRACKS IN TURBINE-BLADE LEADING EDGE BY USE OF ^{85}Kr GAS. Eddy, William C. Jr. (Industrial Nucleonics Corp., Columbus, Ohio). Isotop. Radiat. Technol.; 7: 277-85(Spring 1970).

Turbine blades were examined by use of radioactive ^{85}Kr gas as a tracer to locate otherwise undetectable cracks. The residual activity found 1 day after ^{85}Kr impregnation by use of Krypton Exposure Technique (KET) was about $1/_{50}$th that of the initial activity. A detection system that incorporates fast-response electronics provided excellent spatial resolution of the detected cracks in less than 1 min at those activity levels remaining 3 hr after impregnation by KET. (auth)

11752 LOW-VOLTAGE-ACCELERATOR NEUTRON RADIOGRAPHY. Iddings, Frank A. (Louisiana State Univ., Baton Rouge). Isotop. Radiat. Technol.; 7: 291-3(Spring 1970).

A simplified system for producing neutron radiographs using a low-voltage-accelerator neutron source is presented. The system produces usable neutron radiographs in 1 min for samples such as electronics, ammunition and explosive devices, and other small specimens. Deuteron beam currents between 3 and 4 ma permit the necessary high neutron outputs, yet allow long target lives. (auth)

11753 NEUTRON RADIOGRAPHY FACILITY AT UNIVERSITY OF TEXAS NUCLEAR REACTOR LABORATORY. Bouchey, G. D.; Gage, S. J. Univ. of Texas, Austin). Isotop. Radiat. Technol.; 7: 294-6(Spring 1970).

The University of Texas neutron radiography facility, which is installed in a vertical beam tube from the 250-kW TRIGA reactor, is described. (auth)

Radioactive Material Handling

Refer also to abstracts 11668, 11717, 11721, 11722, 13531, 13578, and 13613.

11754 (KFK-1037) FIXING OF RADIOACTIVE RESIDUES IN BITUMEN. Kluger, W.; Krause, H.; Nentwich, O. (Kernforschungszentrum, Karlsruhe (West Germany)). Aug 1969. 62p. (CONF-681226-1). Dep. CFSTI (U. S. Sales Only).

From Research Coordination Meeting on the Incorporation of Radioactive Wastes in Bitumen, Dubna, USSR.

Experiments were performed on simulated evaporator concentrate solutions because most of the radioactive waste water is decontaminated by evaporation. Salt solutions, chemical sludges, plastics, organic ion exchangers, and organic waste solutions were stirred into bitumens. Parameters affecting the process and the results are discussed. (J.C.W.)

11755 (LA-4325) APPLICATION OF S_n CALCULATIONS TO THE EVALUATION OF A SHIPPING CONTAINER FOR SMALL QUANTITIES OF FISSILE RADIOACTIVE MATERIAL. Smith, David R. (Los Alamos Scinetific Lab., N. Mex.). 24 Oct 1969. Contract W-7405-eng-36. 4p. Dep. CFSTI.

One-dimensional S_n calculations were used to evaluate the safety of some simple shipping containers for fissile radioactive materials. (auth)

11756 (ORNL-tr-1841) PROBLEMS OF DISPOSAL OF RADIOACTIVE WASTES IN GERMANY. Holtzem, H.; Schwibach, J. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Atomwirt., Atomtech.; 12: 413-17(1967). 13p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 23248.

11757 VIEWING WINDOW (4 Oct 1967) (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-1944).

7 drawings.

A viewing window is described, which is used in a high-density shielding wall to attenuate gamma and fast neutron radiations. The window is constructed so that it can be easily removed from the wall for cleaning or repairing. Optical coupling between panes of glass creates two separate cavities, one of which is demineralized water and the other a specialized oil which is resistant to radiation degradation. Non-browning plate glass of 2.7 density is used with the demineralized water and 6.2 density lead glass is used to contain the oil. The window will withstand temperatures from 70 to 100°F, and radiation from a point source of 1×10^{12} fissions per second at a distance of 24 in. from the window. (For details see TID-4100, Suppl. 56.) (F.S.)

11758 LMF CASK (Aug 1969) (Engineering Materials). (Savannah River Operations Office (AEC), Aiken, S. C.). (CAPE-1949).

12 drawings.

A 16-ton LMF cask, used in overland shipment of ^{60}Co from the Savannah River Plant to off-plant sites, is described. The cask, which is encased in stainless steel and shielded with Pb, is approximately a five ft cube. Fins are provided on all sides for efficient heat transfer and the lid is vented to facilitate vapor release. Two trunions, located on opposite sides of the cask, provide a means of attachment for a removable lifting-yoke. Up to 270,000 Ci of ^{60}Co clad in Al or stainless steel may be shipped in the cask with a specific amount of water coolant depending on the ^{60}Co payload. With a low-heat payload in winter, methanol antifreeze is used. Maximum heat with antifreeze should not exceed 90°F. The loaded cask with antifreeze will withstand temperatures of −40°C up to 130°F. Internal pressure of the cask is 30 psig and the cask must be leak-free at 45 psig by actual testing. Radiation shielding effectiveness is maintained in a free drop of 30 ft (except on top) and during a 30 min exposure to 1475°F heat. (For details see TID-4100, Suppl. 56.) (See also 23: 50091.) (F.S.)

11759 BISMUTH SHIPPING CASK (29 Dec 1969) (Engineering Materials). (Savannah River Operations Office (AEC), Aiken, S. C.). (CAPE-1951).

4 drawings.

The design of a cask used to ship irradiated Al-clad Bi slugs containing ^{210}Po from the Savannah River Plant to off-plant sites

is presented. The cylindrical cask, which is 4 ft 8¾ in. high with a 3 ft 3 in. dia, has a 5-in. thick stainless-steel shell. Fully loaded, the cask and lid weigh ~11,000 lbs. The cask is pressurized and has fins for efficient heat transfer. A vented lid is bolted on for positive closure. A removable yoke is fitted around opposite sides of the cask for lifting. Maximum ^{210}Po capacity is nominally 250,000 Ci but this varies with air temperature. Up to 60 Al-clad irradiated slugs may be shipped provided an internal pressure of 138 psig and water-coolant temperature of 360°F are not exceeded. Pressure and coolant-water temperature are controlled by limiting the payload on the basis of air temperature at the time of shipment. Water-coolant temperature must not exceed 212°F when the cask is sealed for shipment. When more than 40 slugs are shipped, slugs out of water must have heat generation of not more than 20° above coolant-water temperature. In winter, low-heat payloads require antifreeze additions in the coolant water. The cask withstands 30 ft free-drops on hard surfaces, 30 min exposure to 1475°F heat, infinite immersion in 3 ft of water and ambient temperature between −40 and +130°F. A rupture disk is provided for relief at 1390 psig. (For details see TID-4100, Suppl. 56.) (See also 23: 50092.) (F.S.)

11760 12 INCH CALCINER MODULE (5 Jun 1968) (Engineering Materials). (Idaho Nuclear Corp., Idaho Falls). (CAPE-1945). 29 drawings.

The design of a 12-in. calciner, used in fluidized-bed calcination of radioactive liquid wastes in the Waste Calcining Facility at the Idaho Chemical Processing Plant is presented. Calcining capacity is limited by the rate of heat transfer from the exchanger bundle to the fluidized bed. The waste is converted to granular, free-flowing solids which occupy about 10% of the original solution volume providing a safer form for long-term storage. Waste solutions are sprayed into a fluidized bed, which is maintained at 400 to 500°C. Solid wastes deposit in layers on the bed particles and decompose to oxides. Off-gases are decontaminated in a wet off-gas scrubbing system, silica-gel adsorbers, and a filter system. The calciner vessel contains a fluidizing-gas-distribution plate, fuel and feed nozzles, overflow standpipes, fluidizing-air preheat coil and a rupture disc with a bursting pressure of 28 psia at 500°C. The off-gas, after leaving the top of the calciner vessel passes through a primary cyclone separator where elutriated solids are removed and collected in a fines pot. The off-gas is scrubbed in a venturi scrubber, after which the gas and liquid are separated in a secondary cyclone. After passing through a condenser and steam jet, the off-gas is vented from the building. The highest waste-feed rate which has been attained is 11.3 gal/hr-ft^2. (For details see TID-4100 Suppl. 56) (See also 23: 47723) (F.S.)

Vacuum Engineering

Refer also to abstract 13226.

INSTRUMENTATION

Radiation Detection Instruments

General Detectors and Monitors

Refer also to abstracts 12165 and 13538.

11761 (BARC–438) REALIZATION OF SOLID-STATE IONIZATION CHAMBER. Deshpande, R. Y. (Bhabha Atomic Research Centre, Bombay (India)). 1969. 71p. Dep. CFSTI (U. S. Sales Only).

The basic principles of solid-state ionization chambers for high resolution nuclear spectroscopy are reviewed. Topics include the dielectric behavior of solids, charge production, statistics of recombination and trapping, process of charge collection and pulse shape, charge collection efficiency, electrical structure of solid-state counters, and noise and limitations to energy resolution. Also, a brief state of the art review of semiconductor detectors is presented. (W.H.K.)

11762 (BARC–440) A BF_3 ANNULAR COUNTER. Sunta, C. M.; Muthukrishnan, G.; Murthy, K. B. S. (Bhabha Atomic Research Centre, Bombay (India)). 1969. 16p. Dep. CFSTI (U. S. Sales Only).

A BF_3 annular counter is made with 12 anode wires. The annulus has inner and outer diameters 30.9 and 36.8 cms respectively and height 22.9 cms. The annular volume is filled with $^{10}BF_3$ gas at 60 cms of Hg pressure. The performance and characteristics of the counter including the variation of counting efficiency with change in the neutron source position along the vertical and radial axes are studied. The counter provides a geometry of 2.4 π with the source at its geometrical center. This can be further increased by increasing the length. The counter is used to measure neutron emission from bulk plutonium samples. Neutron multiplication in natural uranium blocks also is studied. (auth)

11763 (BARC–443) COMPENSATION AND PURIFICATION OF Si AND Ge. Chaudhry, Ramesh (Bhabha Atomic Research Centre, Bombay (India)). 1969. 24p. Dep. CFSTI (U. S. Sales Only).

Present state of affairs as regards the purification and compensation of Si and Ge is reviewed from the point of view of fabrication of semiconductor detectors. Salient features of some processes of fabrication of detectors are enumerated. The review can be easily generalized to other processes and semi-conductor materials for fabrication of semiconductor detectors. (auth)

11764 (CEA-CONF–1410) EQUIPMENT FOR THE DETECTION OF RESIDUAL FUEL IN LEACHED HULLS BY NEUTRON COUNTING. Jover, Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 8 Jul 1969. 8p. (CONF-691017–6). Dep. CFSTI (U. S. Sales Only).

From 16th Nuclear Science Symposium, San Francisco, Calif.

Equipment has been developed for detecting a small amount of fissile materials rèmaining in hulls, after an irradiated fuel dissolving operation. The equipment described is running in the French fuel processing plant AT-1 located at La Hague (France). The method includes leached-hulls irradiation by a neutron generator and delayed-neutron counting techniques. It makes possible to monitor one basketful of leached-hull pieces in 30 minutes and to detect an amount of 20 milligrammes uranium 235 equivalent with 100% accuracy. (auth)

11765 (CEA-R–3649) CONTRIBUTION TO THE DEVELOPMENT OF A GAMMA RADIATION CAMERA FOR USE IN SCINTIGRAPHY. Felix, Jacques (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Oct 1969. 63p. (In French). Dep. CFSTI (U. S. Sales Only).

Properties of the detection head of a multichannel collimating grid camera are studied. The object is to show the disadvantages of present equipment, and to propose possible solutions for overcoming them: first by improving the methods used for collecting data, and the performances of the equipment doing the collecting; and secondly by devising methods for processing the data to reduce image distortion and, particularly the astigmatism due to the collimator. The first part deals with the study of the formation of the image by means of the collimating grid, the second with the examination of many systems which could be used for acquiring data. The last part summarizes the experiments carried out and proposes an experimental program for the development of a prototype. (auth)

11766 (INR–1092) PROPORTIONAL COUNTER FOR MEASURING beta EMITTING SOURCES OF LARGE AREA. Ciarkowski, Adam (Institute of Nuclear Research, Warsaw (Poland)). 1969. 16p. Dep. CFSTI (U. S. Sales Only).

The construction and important characteristics of the proportional counter enabling measurement of β sources of large area exceeding 120 × 150 mm, are described. The methods and results of researches concerning gas amplification, distribution of efficiency of detection of β particles emitted from various points of the measured source area and the effect of the lack of electric conductivity between the source and the cathode, are presented. (auth)

11767 (JINR–P-1-4815) ON THE ACCOUNT OF PARTICLES LEAVING THE DETECTOR DUE TO THE MULTIPLE COULOMB SCATTERING. Kostanashvilli, N. I.; Polyakova, R. V.; Yarba, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1969. 8p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The correction is calculated, which takes into account particles leaving detecting systems due to the multiple Coulomb scattering. The method suggested can be applied for the case of large ionization losses. The calculated results for photoemulsion agree well with experimental data. (auth)

11768 LIQUID SCINTILLATION COUNTING. Bernstein, D. M.; Raven, A. B. Electron. Equip. News; 46–53(Nov 1969).

The fundamental processes involved in liquid scintillation counting are described, together with the associated electronics. Quenching and temperature control are discussed. (UK)

11769 REACTOR NEUTRON MEASUREMENTS WITH FISSION FOIL–LEXAN DETECTORS. Rago, P. F.; Goldstein, N.; Tochilin, E. (Naval Radiological Defense Lab., San Francisco). Nucl. Appl. Technol.; 8: 302-9(Mar 1970).

A fission foil-Lexan detector system has been developed to monitor reactor neutrons. It is similar to the system based on counting fission γ rays but has some advantages: i.e., permanently recorded tracks that can be read any time after exposure; integrated recording; microgram amounts of fissionable material needed; and the elimination of specialized γ-ray counting equipment. Fission product damage tracks in the Lexan (or mica) are counted under an optical microscope. For thick foils, fluence is determined from the sensitivity factor of 1.16×10^{-5} tracks/neutron-barn. Fluence measurements with the two systems are compared for several reactor environments while dose measurements are compared with tissue-equivalent calorimeter values. The use of ^{232}Th to replace ^{238}U as the fissionable isotope for the energy interval of 1.5 to 3 MeV, and of ^{235}U to replace ^{239}Pu for energies below 600 keV, was also investigated. Neptunium is retained as the fissionable material for the energy interval 600 keV to 1.5 MeV and the sulfur activation detector for energies above 3 MeV. (auth)

11770 PERFORMANCE OF AN AUTOMATIC ANALYSER FOR TRITIUM IN URINE. Osborne, R. V. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Health Phys.; 18: 87-9 (Jan 1970).

Figures are given to show that an automatic analyser for tritium in urine can give results rapidly and accurately to allow the exposed workers to associate tritium hazards with particular locations, habits, or jobs. The standard error in estimating the correct concentration from an autoanalyser is shown to be ±12% at 10 μCi l^{-1}, if care is taken that the exposure was ended at least one hour before the urine sample was delivered. (UK)

11771 GAMMA SELF ATTENUATION AND GEOMETRY OF MEASUREMENT WITH A SINGLE CRYSTAL IN SPECTROMETRY OF WHOLE-BODY COUNTING. Joyet, G. (Kantonsspital, Zurich). Rev. Med. Liege; 23: Suppl. No. 1, 177-80(Oct 1968). (In French).

The characteristics of a whole-body counter that uses a large 4 × 8 in. single crystal with steel shielding are discussed. The sensitivity of the equipment is sufficient to detect nCi amounts of radioactivity. In order to reduce background of the installation, the shielding used consists of 18 cm of steel, 3 mm of Pb, and overpressure forced air ventilation. The background is reduced by a factor of 110, as compared to the normal unshielded value. The dimensions of the chamber are 270 × 190 × 240 cm. It was shown by measurements that the size of the subject measured affects the standardization, and it was necessary to study the self-attenuation and the crystal-subject geometry of the system. The profile of the subject was taken to be a semielliptic form, with a horizontal semiaxis of 50 cm and a vertical axis of 62 cm, measured from the crystal center. Tests on phantoms of several

shapes showed that at energies from 0.4 to 1.5 MeV the background varied by ±4%, independently of the trunk circumference. A method of triangulation was used to calculate low activities or photopeaks that varied considerably from a Gaussian distribution. Numerous measurements of ^{40}K and ^{137}Cs radioactivity in an average population were performed, and typical cases of occupational contamination with other radioisotopes were studied. (BBB)

11772 METHODOLOGIC PROBLEMS POSED BY WHOLE-BODY COUNTING. APPLICATIONS TO THE STUDY OF METABOLISM OF IRON AND IODINE. Tubiana, M.; Daburon, M. L.; Parmentier, C.; Fragu, P. (Institut Gustave Roussy, Villejuif, France). Rev. Med. Liege; 23: Suppl. No. 1, 190-202(Oct 1968). (In French).

Results of whole-body counting of ^{59}Fe and ^{131}I are discussed. The 2 major counting problems encountered were found in obtaining the proper geometry and sensitivity of measurement, and problems due to self-absorption of the radioactivity in the tissues of the subjects studied. Different types of equipment used for whole-body counting are discussed. These include equipment such as a single, uncollimated crystal, or where 2, 4, or 8 fixed uncollimated crystals are used. Where a single crystal is used, the subject is measured while positioned either in a reclining chair or located in an arc where each segment of the body is viewed by the crystal at the same solid angle. The arc of the circle generally used is from 0.5 to 1 m. This method was best suited to high levels of radioactivity, so that this limits the time during which the metabolism of a radioisotope can be studied. The results of studies with ^{59}Fe and ^{131}I made in these 2 types of positions are discussed and compared. The principal requirements for the measurements were that a compromise was needed between the counting efficiency and independence of the geometrical factors, the metabolic pattern of the radioelement studied and the effect of self-absorption on the counting level had to be considered, and various stages of metabolism had to be taken into account during the studies in order to avoid improper conclusions. (BBB)

11773 TECHNICAL PROBLEMS RAISED BY CLINICAL USE OF GAMMA SPECTROMETRY EQUIPMENT FOR WHOLE-BODY COUNTING. Jammet, H.; Gongora, R.; Lafuma, J. (Fondation Curie, Paris). Rev. Med. Liege; 23: Suppl. No. 1, 203-9(Oct 1968). (In French).

The clinical whole-body diagnostic radioisotope laboratory at the Fondation Curie is described. In order to reduce the irradiation hazard, the shielded area is located in the basement. Its walls and ceiling are lined with Pb bricks 10 cm thick, with radioactivity concentrations from 2 to 5×10^{-6} μCi/g. The floor consists of steel 0.14 cm thick, free of Co. The dimensions of the room are 3.43 × 2.54 m, with a 2 m height. The detectors used include a 4 × 8 in. cylindrical crystal, with 3 photomultipliers, and 2 smaller probes. The detectors are remotely and manually operated. Serial measurements can be taken in several positions by prior programming of the operation. Measurements are recorded with a multichannel analyzer and 3 single channel analyzers. The measurement results can be stored on magnetic tape or on a plotter. The equipment is used for relative and absolute dosimetry, measurement of effects of dosimetry parameters, such as topography, morphology, or measurement of irradiation energy. The types of phantoms used include a sectional ellipse, and a whole-body phantom. Methods of measurements with the phantoms are described and discussed. (BBB)

11774 TESTING OF A NEW TYPE OF WHOLE-BODY COUNTER. PRELIMINARY RESULTS. Delwaide, P. A.; Heusghem, C. (Univ., Liege). Rev. Med. Liege; 23: Suppl. No. 1, 209-15(Oct 1968). (In French).

The whole-body research counter installed at Liege University is discussed. Results obtained after 2 months of operation are reported. The equipment, including room shielding and method for transporting subjects, types of detectors, and electronic equipment is described. The tests conducted with the counter included verification of stability, study of background noise, study of selectivity between radioisotopes of different energies, and a study of the possibilities of quantitating ^{40}K. The limit of detectability for ^{40}K was 0.09 nCi in a 1 g sample of K. It was possible to detect K by whole-body measurements down to a level of 5 g with a probability of 99%, with an error of about 1%. The performance of the whole-body counter is discussed in terms of background noise, efficiency, resolution, precision, sensitivity, and specificity. The specificity of the counter, which is related to the resolution, gave the poorest results. (BBB)

11775 LOW-ENERGY RADIOACTIVITY AND AVALANCHE SEMICONDUCTOR RADIATION DETECTORS. Johnston, P. A.; Huth, G. C.; Lockert, R. J. (General Electric Co., Philadelphia). Isotop. Radiat. Technol.; 7: 266-77(Spring 1970).

The technology of avalanche semiconductor radiation detectors is reviewed briefly, and the advantages of avalanche detectors are illustrated by a discussion of various applications, including x-ray fluorescence measurements, beta-particle detection, and tracer usage—especially in medicine. The chief advantages claimed for this type of detector are that it is windowless, has high internal gain, is rugged in construction, and is able to operate satisfactorily over a wide range of temperatures. (auth)

11776 PHOTOGRAPHIC MEASUREMENT OF β-RAYS AND ELECTRON BEAMS. Takahara, Hikaru (Chiba Univ., Japan). Chiba Daigaku Bunrigakubu Kiyo, Shizenkagaku; 5: 231-4(Nov 1968). (In Japanese).

In order to utilize photographic emulsion for the measurement of a high energy electron beam generated by an accelerator, its properties were investigated. For the photographic emulsion, γ-ray badge film was used as a high sensitive film and industrial x-ray film as a low sensitive film. The betatron was used for a high energy electron beam source, and $^{90}Sr-^{90}Y$ for a β-ray source. The dependence of these films on β-ray dose rate was almost constant, except when a high sensitive film was used for measuring the radiation of high dose rate. It is difficult to utilize a high sensitive film when the dose is over 1 Rad. While, in the case of x-ray film, the density is insufficient when the dose is below 1 Rad, but this film is suitable for the measurement of dose up to about 15 Rad. With a 15 MeV electron beam, and by adopting a low sensitive film, the relation between density and dose was examined by means of depth dose curves and density distribution. In this case, the density greatly varied with the developing conditions of the film, but the photographic method is very effective for the measurement of dose-distribution. Generally, the deviation of density in the irradiated field is ±15%, and that is caused not only by the variation of the developing condition but also by the fluctuation of the electron beam. (NSA of Japan)

11777 EXTRAPOLATION IONIZATION CHAMBER. Radiography; 35: 145(Jun 1969).

An extrapolation ionization chamber for the measurement of the dose rate from β radiation is described. The ionization chamber has a 1 mg/cm² β window. Its application is principally in the field of health physics and medical research and in hospitals for the calibration of therapeutic radioactive applicators. Variations of up to 1,000 to 1 in the sensitivity of the instrument, without any change in the associated electrometer amplifier, were effected by interchanging 1 of the 4 electrodes provided. A special feature of the instrument is the unique construction of these electrodes in which all internal voids from which spurious ionization currents might be collected are excluded. The chamber is constructed of a dielectric selected to provide β absorption characteristics equivalent to those of aqueous tissue over a wide range of energies (^{35}S to ^{90}Y). In order to simulate the dose at different depths in tissue, provision was made for different thicknesses of material to be interposed between source and window. Provision was made for checking the uniformity of a source by mounting it on a 2 axis micrometer slide to permit controlled movement in 2 horizontal directions. For controlled movement of the source in the vertical direction a coarse control was provided in addition to a fine micrometer control, accurate vertical positioning being especially important when measuring surface dose-rates from sources of soft β radiation. The instrument was designed to accommodate radiation sources of up to 6 in. dia. The depth of the ionization chamber was adjusted by rotating the window assembly which was graduated in terms of depth change to within 0.003 mm. An adjustable cursor was provided to effect an absolute depth calibration. An additional interchangeable 2π gas flow counting electrode can be supplied. This permits correlation between tissue dose rate and the radioactivity producing it without disturbing the source. (BBB)

11778 EXPERIMENTS OF $(\gamma-\alpha)$ REACTIONS. Abe, Ken (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 1: No. 2, 41-8(Dec 1968). (In Japanese).

A "pulse division method" for pulse shape discrimination with a single p-i-n solid-state detector was extended. While a long transmission cable (200 m, of 10D-2V) vitiated the particle-type information involved in the detector signal, a clear separation ($\Delta H/H \approx 20\%$) between protons and alpha particles from $Be(\gamma,\bar{\alpha})$ was obtained. A nonintegrating stretcher was found to be exclusively suited for multichannel analysis of the quotient pulses. (auth) (NSA of Japan)

11779 FABRICATION OF A LARGE VOLUME Ge(Li) DETECTOR. Ishizuka, Yasuhiro; Kurano, Yukinaho; Yoshii, Nahomi; Nagahara, Yukio; Nagahara, Teruaki; Hattori, Manabu (Yokohama

National Univ., Minami, Japan). Sci. Rep. Yokohama Nat. Univ., Sect. I; No. 15, 9-16(Jan 1969).

Difficulties in fabricating and utilizing a large Ge(Li) detector of planar or double open-ended coaxial type are discussed on the basis of the increase of the surface leakage current, very long drift time, and problems in the etching procedure. The advantages and disadvantages of the single open-ended coaxial type, compared with other types, are considered. Fabrication of a large volume Ge(Li) detector of single open-ended type is described. How it was possible to minimize the material loss compared with Fiedler's method is shown. Furthermore, the heat-up process was interposed during the drift procedure which distinctly improved the drift efficiency. The volume of the final detector is 35 cm^3, and the energy resolution is 5.2 keV with the 2.754-MeV γ-ray from ^{24}Na. Leakage current vs bias voltage, γ-ray spectrum from ^{24}Na, resolution and pulse height vs bias voltage, and resolutions vs γ-ray energy are illustrated. Energy resolution is 4.2 keV at 1.333 MeV. Estimated capacitance is about 80 pF. The results of collimated γ-ray scanning and the efficiency vs energy curve at one source distance are also illustrated. (BBB)

11780 NATURE OF QUENCHING. Jaffe, M.; Ford, L. A. (Food and Drug Administration, Washington, D. C.). Int. J. Appl. Radiat. Isotop.; 21: 49-52(Jan 1970).

The Scintillation Attenuation Factor (SAF), the attenuation of scintillation efficiency produced by 1 m-mole of quenching agent was measured for a number of alkyl and aryl halides and aliphatic alcohols commonly employed in organic analytical and synthetic procedures. Quenching increased on additional substitution of chlorine in the molecule and the position of substitution was found to be important in determining the quenching potency of the entering substituent. The SAF values also increased with the lengthening of the carbon chain. The quenching of fluorescence from ultraviolet radiation bore no clear relationship to the quenching of fluorescence due to ionizing radiation. Counting efficiency decreased as an exponential function of the concentration of the quenching agent; this was shown by a plot of counting efficiency (normalized to an unquenched standard) vs. concentration of quench. (UK)

11781 DETERMINATION OF THE SENSITIVITY OF SPHERICAL DETECTORS OF NEUTRONS IN THE ENERGY RANGE BELOW 10 keV. Andreeva, L. S.; Keirim-Markus, I. B.; Uspenskii, L. N.; Filyushkin, I. V. (Inst. of Biophysics, Moscow). Prib. Tekh. Eksp.; No. 4, 61-4(Jul-Aug 1969). (In Russian).

Results of measurements of sensitivities of spherical neutron detectors are described. Measurements were made using the time-of-flight method. Corrections to the sensitivity due to delayed neutrons and the neutron lifetime in the moderators were determined. (tr-auth)

11782 RECORDING OF BETA ACTIVITY WITH LOW BACKGROUND. Volkov, V. G.; Izotov, N. I.; Ratner, B. S. (Inst. of Physics, Moscow). Prib. Tekh. Eksp.; No. 4, 64-5(Jul-Aug 1969). (In Russian).

A system for recording beta activity in 4π geometry with a background of 1.2 pulses/min is described. (tr-auth)

11783 APPLICATION OF TOPAZ FOR RECORDING NUCLEAR FISSION. Perelygin, V. P.; Shadieva, N. Kh. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp.; No. 4, 53-5(Jul-Aug 1969). (In Russian).

The method for using topaz for the recording of nuclear fission fragments was worked out. It was determined that the efficiency for detecting fission fragments is 70 ± 10% and that this detector has a threshold of recording charged particles with $Z > 18$. (tr-auth)

11784 DOUBLE IONIZATION CHAMBER WITH ENLARGED UTILIZATION COEFFICIENT FOR NEUTRONS DURING ACCELERATOR OPERATION. Artemev, Yu. M. (Radium Inst., Leningrad). Prib. Tekh. Eksp.; No. 4, 55-6(Jul-Aug 1969). (In Russian).

A double ionization chamber with grids for precision measurements of kinetic energy of fission fragments with improved utilization of the beam of neutrons is described. Due to the application of special electrodes that smooth out the field, the source of neutrons could be placed substantially closer to the fissionable material. (tr-auth)

11785 QUENCHING OF LIGHT BURSTS IN LIQUID SCINTILLATORS BY A DIMINISHING ELECTRIC FIELD. Zhiltsova, L. Ya.; Matveeva, E. N.; Medvedev, M. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp.; No. 4, 57-8 (Jul-Aug 1969). (In Russian).

Experimental data on the quenching of scintillations excited by ^{60}Co gamma rays in liquid scintillators by means of a diminishing electric field are presented. (tr-auth)

11786 BIOLOGICAL EQUIVALENT RESPONSIVE NEUTRON SURVEY METER. Saylor, William P. Jr.; Childers, Herman M. (to American Machine and Foundry Co.). U. S. Patent 3,452,197. 24 Jun 1969. Filed 24 Feb 1965.

The present invention comprises a scintillation detector system for detecting and measuring neutron radiation in terms of relative biological effectiveness and includes a probe having a neutron sensor which is a unitary element made up of a plurality of laminae of a synthetic hydrogen-containing transparent plastic, the interfaces of said laminae being separated by a layer of charged particle detecting material combined with a lithium-6 compound. (Offic. Gaz.)

11787 TRACK DISTORTION IN A WILSON CHAMBER. Denisova, V. G.; Lebedev, A. M.; Fetisov, I. N. (Inst. of Physics, Moscow). Prib. Tekh. Eksp.; No. 4, 42-4(Jul-Aug 1969). (In Russian).

The results of measurements on track distortion under known temperature conditions are given. Due to careful thermostat control, the application of special optics, and other measures, the probable error in the curvature of tracks 45 cm in length was decreased to 3×10^{-3} m^{-1} (radius of curvature 330 m). (tr-auth)

11788 ION DETECTION USING A CONTINUOUS CHANNEL ELECTRON MULTIPLIER. Yeilin, E.; Yin, L. I.; Adler, I. (Goddard Space Flight Center, Greenbelt, Md.). Rev. Sci. Instrum.; 41: 18-19(Jan 1970).

A spiral type continuous channel multiplier was used for pulse counting heavy positive ions. The shape of the output pulses was studied. The pulse risetime was found to be very long and composed of numerous after-pulsing as revealed by the "staircase" appearance of the pulse. As a consequence, the count rate capability is greatly hampered. Detection of the positive ions by a catcher foil and collection of the secondary electrons lead to a smooth pulse clean of any after-pulsing and to a greatly improved count rate capability. (auth)

11789 SECONDARY ELECTRON DETECTION IN A FIELD EMISSION SCANNING MICROSCOPE. Crewe, A. V.; Isaacson, M.; Johnson, D. (Univ. of Chicago). Rev. Sci. Instrum.; 41: 20-4(Jan 1970).

Operation of a field emission scanning microscope in a secondary electron mode is described. The microscope uses only a field emission electron gun without auxiliary lenses and a silicon surface barrier detector to detect the secondary electron current. Resolution of 100 to 200 Å with beam currents of 10^{-11} to 10^{-10} A is reported. Micrographs of a variety of specimens are shown. (auth)

11790 FAST NEUTRON AND GAMMA RAY RISETIME DIFFERENCES FOR 8 TO 10 MeV PULSES IN A LARGE NaI(Tl) CRYSTAL. Jaszczak, R. J.; Nutt, R.; Macklin, R. L. (Oak Ridge National Lab., Tenn.). Rev. Sci. Instrum.; 41: 28-30 (Jan 1970).

A dissimilarity in the risetime distribution of 8 to 10 MeV pulses from a 22.9 by 30.5 cm NaI(Tl) crystal due to fast neutrons and those due to gamma rays of equivalent energy has been observed. The time spectra were obtained using low and high level discriminators triggering at 100 keV and 2.5 MeV, respectively. The NaI(Tl) crystal was viewed by six matched RCA 4524 bialkali photomultiplier tubes. The time resolution of this system (using a small plastic scintillator to obtain one time reference) for 4.43 MeV gamma rays using leading edge timing is 2.5 nsec. The fast neutrons undergo inelastic collisions within the crystal prior to capture. The mean time between collisions for 3 MeV neutrons in NaI is 2.8 nsec; thus, the time interval between the two discriminators is longer for a typical fast neutron than for a gamma ray of equivalent energy. This results in a degradation of the time spectrum due to the fast neutrons. The 8 to 10 MeV gamma ray risetime distribution is symmetric, having a time resolution (FWHM) of 2.75 nsec. The neutron risetime distribution has a tail on the side corresponding to longer time intervals between the two discriminator outputs. It is shown that it is possible to reduce the number of pulses due to neutrons in the 8 to 10 MeV region by $\frac{1}{3}$ by setting a time window. Estimates of an increased capability to discriminate through the use of a pulsed accelerator and a beam pickoff (thereby allowing the time interval between neutron emission and first inelastic scattering to be observed) are presented. (auth)

11791 A SEMICONDUCTOR DETECTOR FOR LOW ENERGY PARTICLE AND QUANTUM SPECTROSCOPY AT ROOM TEMPERATURE. Keil, G. (Technische Hochschule, Munich). Nucl. Instrum. Methods; 78: 213-18(1970).

A small-area silicon guard-ring diode (2.5 mm dia.) was used for room temperature spectroscopy of low energy particles and quanta. The 6.4 keV X-ray peak of ^{57}Co was resolved; the best fwhm obtained was 3.2 keV with equal noise contributions from the detector and the charge-sensitive preamplifier. Despite the small size of the diode the γ-peaks of ^{57}Co (122 and 136.3 keV) were clearly resolved. The alloyed gold contact for the bulk crystal was found to cause unwanted Au-Kα and Kβ fluorescence peaks. With the detector a tritium β-spectrum was measured; the counting efficiency was about 50%. (auth)

11792 NEW PULSE HEIGHT TO CLOCK PULSE CONVERTER AND ITS APPLICATION TO NEUTRON DOSIMETRY. Furuta, Yutaka; Kinbara, Seturo; Miyakoshi, Jun-ichi (Japan Atomic Energy Research Inst., Ibaraki). Rev. Sci. Instrum.; 41: 11-15 (Jan 1970).

The pulse height to clock pulse converter is an electronic digital integrator and its application for gamma ray dosimetry (gamma ray pulse dosimeter) has been reported recently. In the present study, a new integration method was adopted for the pulse height to clock pulse converter in addition to its transistorization. The results of its application for neutron dosimetry are also described. (auth)

11793 ANGLE DETERMINATION BY SONIC SPARK-CHAMBER IN NUCLEAR SCATTERING EXPERIMENTS. Clarke, N. M. (London Univ.); Burge, E. J.; Smith, D. A.; Dore, J. C. Nucl. Instrum. Methods; 78: 229-37(1970).

A charged-particle detector system is described which uses a sonic spark chamber to determine the angle of scattering of the particles within a large solid angle without loss of angular resolution. The selection, design and testing of the components of the detector system are discussed, and an account given of the performance of the complete system including the electronic logic. The limitations of the detector are considered and examples given of its applications. (auth)

11794 A NEW METHOD OF FORMING SCINTILLATORS FOR ELECTRON COLLECTORS. Hatzakis, M. (Thomas J. Watson Research Center, Yorktown Heights, N. Y.). Rev. Sci. Instrum.; 41: 128(Jan 1970).

A method for forming the scintillator–light pipe junction used for the detection of secondary electrons in a scanning electron microscope is briefly described. The light pipe is finished to a polished hemisphere at one end, and the hemispherical surface is coated with plastic scintillator by dipping or brushing. (W.H.K.)

11795 STRAGGLING AND PARTICLE IDENTIFICATION IN SILICON DETECTORS. Bichsel, H. (Univ. of California, Berkeley). Nucl. Instrum. Methods; 78: 277-84(1970).

The distribution functions for the straggling of charged particles in silicon detectors are given in a comprehensive graphical form. Approximate quantum mechanical corrections have been applied to the Vavilov functions. A simple identification procedure for use with a digital computer is described. (auth)

11796 EXPERIMENTAL PHOTOPEAK EFFICIENCIES FOR A WELL TYPE NaI(Tl) CRYSTAL BELOW 100 keV. Prasad, P. Rama; Rama Rao, J.; Kondaiah, E. (Andhra Univ., Waltair, India). Nucl. Instrum. Methods; 78: 255-7(1970).

Photopeak efficiencies for a 6.5 × 6.5 cm well type NaI(Tl) crystal with 0.8 cm well dia. and 3.2 cm well depth have been determined at photon energies 36, 52, 74 and 84 keV for cylindrical sources of dia. 0.5 cm and heights 0.5 cm and 3.0 cm placed in the well. By a process of simulation, the self-absorption effects have been taken into account experimentally in typical absorbing media Al, Cu, Sn and Pb covering the periodic table. The data are presented in graphical form together with the data reported at higher energies for the same crystal by Tiwari and Kondaiah. (auth)

11797 GEOMETRICAL ATTENUATION FACTORS FOR DIRECTIONAL CORRELATION EXPERIMENTS. Arns, R. G.; Caldwell, S. E.; Monahan, W. G. (Ohio State Univ., Columbus). Nucl. Instrum. Methods; 78: 295-9(1970).

Experimentally determined values are given for the attenuation factors due to finite solid angle in directional correlation measurements. The method is applied to cylindrical NaI(Tl) detectors and Ge(Li) detectors. Experimental determination of attenuation coefficients is especially useful in the latter case due to the uncertainty regarding the position and extent of active volume of the Ge(Li) detector. The attenuation factors for escape peaks differ from those for the full-energy peaks of the Ge(Li) detectors. Results are given for specific detectors and geometries and verified experimentally. (auth)

11798 A FOURFOLD COINCIDENCE SYSTEM TO MEASURE POSITRON-GAMMA ANGULAR CORRELATIONS. De Beer, A.; Blok, H. P.; Blok, J. (Vrije Univ., Amsterdam). Nucl. Instrum. Methods; 78: 19-24(1970).

A method is described to measure positron-gamma angular correlations. The positrons are detected in a plastic scintillator. The disturbance of the energy selection, caused by Compton scattering of annihilation quanta in the plastic, has been avoided by counting these quanta simultaneously in two NaI(Tl) crystals placed face to face near the plastic. The problem of subtracting random coincidences in the fourfold coincidence system is discussed and the results of test measurements on ^{86}Rb and ^{22}Na are compared with previous results. (auth)

11799 MEASUREMENT OF ANGULAR CORRELATION SOLID ANGLE CORRECTIONS FOR A COAXIAL Ge(Li) DETECTOR. Raeside, D. E.; Wiedenbeck, M. L. (Univ. of Michigan, Ann Arbor). Nucl. Instrum. Methods; 78: 331-2(1970).

Experimental finite solid-angle corrections have been determined for a coaxial Ge(Li) detector. A comparison between these experimental values and calculated values is shown. (auth)

11800 TIME RESOLUTION IN LEADING-EDGE AND CROSSOVER TIMING. El-Wahab, M. A.; El-Salam, M. A. (Alexandria Univ., Egypt). Nucl. Instrum. Methods; 78: 325-7(1970).

The general equation for minimum time-resolution in scintillation counters is established, in which the rise time τ_1 of the S.E.R. function and its decay time τ_2 are inserted. From available data, a relation is computed for coincidence systems, which connects τ_1/τ_2 with the ratio F between crossover width and leading-edge width. (auth)

11801 EFFECTS OF SURROUNDING GASES ON THE OPERATION OF MULTIPLE-WIRE SPARK COUNTERS. Kawata, S.; Maeda, K. (Konan Univ., Kobe, Japan). Nucl. Instrum. Methods; 78: 322-4(1970).

Effects of surrounding gases on the operation of multiple-wire spark counters for detection of α-particles and fast neutrons were investigated, and some mixtures were found to give considerably high efficiencies with good stability. (auth)

11802 A HIGH-RESOLUTION DISCRIMINATION SYSTEM FOR NEUTRON IDENTIFICATION AND THE RECOGNITION OF CHERENKOV EVENTS. Johnson, F. A. (Defence Research Establishment, Ottawa). Nucl. Instrum. Methods; 78: 1-7(1970).

A high-resolution crossover timing system, comprising a constant-fraction of pulse height pulse shaper and a pulse-shape discriminator, is described. The system was designed for neutron identification and employs a stilbene scintillator in conjunction with an RCA 8575 photomultiplier. Recognition of Cherenkov events produced by Compton electrons in the glass window of a photomultiplier is shown to be possible. The practical importance of the recognition of such non-scintillation events to gamma spectroscopy is discussed. (auth)

11803 MULTIWIRE PROPORTIONAL AND SEMIPROPORTIONAL COUNTER WITH A VARIABLE SENSITIVE VOLUME. Grunberg, C.; Cohen, L.; Mathieu, L. (CEN, Saclay, France). Nucl. Instrum. Methods; 78: 102-8(1970).

Properties of multiwire proportional and semiproportional electronegative vapor filled chambers have been investigated. It appears that the sensitive volume may be shrunk in a cylinder about 3 mm in diameter near the wires. In the same manner, time resolutions of the order of 30 ns have been performed. Pulses as short as 15 ns with 20 mV in amplitude have been observed with certain vapor fillings. (auth)

11804 DIFFERENTIAL SENSITIVITY OF LONG SELF-POWERED NEUTRON DETECTORS. Strindehag, O.; Soederlund, B. (Aktiebolaget Atomenergi, Studsvik, Sweden). Nucl. Instrum. Methods; 78: 173-4(1970).

Measurements of the differential sensitivity of two 3.3 m long rhodium detectors are presented. The detectors are to be used in connection with an experiment in the Oskarshamn I reactor for integration of the thermal neutron flux over the full fuel length. (auth)

11805 DEPLETION DEPTH DETERMINATION IN SEMICONDUCTOR RADIATION DETECTORS. Erramuspe, H. J. (Comision Nacional de Energia Atomica, Buenos Aires). Nucl. Instrum. Methods; 78: 175-6(1970).

A technique is described which allows a nondestructive determination of the depletion depth while the crystal is under drift, with practically no interruption of the drifting process. (auth)

11806 THE ASYMPTOTIC METHOD OF DEAD-TIME CORRECTION IN POISSONIAN DISTRIBUTION. Carloni, F.; Cor-

beri, A.; Marseguerra, M.; Porceddu, C. M. (CNEN, Bologna). Nucl. Instrum. Methods; 78: 70-6(1970).

The problem of correcting for dead-time losses in an experimental counting distribution measured with a nonparalyzable device exposed to a Poissonian source of particles is here discussed. An approximate analytical method for estimating the mean frequency of the source and the dead-time of the system is given. The involved statistical and systematic errors are detailed and graphs allowing their rapid determination or the proper design of an experiment are reported. The correctness of the proposed method has been successfully tested against stochastic simulations and experiments. (auth)

11807 FLUENCE MEASUREMENTS FOR 14.7 MeV NEUTRONS. Bliss, C. E.; Eckhoff, N. D.; Donnert, H. J. (Kansas State Univ., Manhattan). Nucl. Instrum. Methods; 78: 86-92 (1970).

The derivation of the sum peak method for absolute activity determination and the equations relating absolute activity to neutron fluence are reviewed. Various curve-fitting techniques to fit Gaussian functions to photopeaks are discussed. Using a Texas Nuclear Neutron Generator as a source of 14.7 MeV neutrons, irradiations were performed for different periods of time using LiF thermoluminescent dosimeters as a relative measure of neutron fluence. Actual fluence values were determined using the sum peak method by counting foils which were irradiated simultaneously with the thermoluminescent dosimeters. Each of the curve fitting techniques yielded fluence values with standard deviations less than ±3% of the fluence value. There were, however, 8–10% differences between fluence values determined by the different curve fitting techniques. (auth)

11808 AN AMPLIFIER, TRIGGER, AND MEMORY FOR SIGNALS FROM PROPORTIONAL WIRE CHAMBERS. Tarle, J. C.; Verweij, H. (CERN, Geneva). Nucl. Instrum. Methods; 78: 93-4(1970).

A circuit has been developed for the amplification and storage of signals from proportional wire chambers. The input sensitivity is ≈0.4 mV and the input impedance ≈2 kΩ. (auth)

11809 ON THE THEORY OF THE RESOLVING TIME OF SCINTILLATION COUNTERS. Akimov, Yu. K.; Medved, S. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Instrum. Methods; 78: 151-3(1970).

The problem of the determination of time fluctuations in scintillation counters has been considered with an arbitrary total mean number of photoelectrons R_0 during a scintillation flash. The fluctuations of R have been taken into consideration. The results of calculations for the leading edge method are given which show the effect of various factors and parameters of a scintillation counter upon its resolving time. (auth)

11810 TEST SYSTEMS FOR ON-LINE dE/dx PARTICLE IDENTIFICATION. Hudson, G. M. (Univ. of Melbourne). Nucl. Instrum. Methods; 77: 197-202(1970).

The effect of straggling on the identification accuracy of dE/dx particle identification systems, especially those employing on-line computers, is examined, and conclusions concerning the accuracy of the digital representation of the incoming signals are drawn. The table lookup scheme is discussed, with particular reference to choice of table index variable, and a method of checking its operation in a way similar to that of other identification systems is given. Two additional techniques for examining identification accuracy as a function of energy are discussed in detail. (auth)

11811 SEMICONDUCTOR-NEUTRON DETECTORS UTILIZING RADIOACTIVE DECAY. Johnson, R. T. Jr. (Sandia Labs., Albuquerque, N. Mex.). Nucl. Instrum. Methods; 77: 189-96 (1970).

A new method for measuring neutron fluences has been developed which consists of detecting induced-electrical changes due to self-ionization from radioactive decay in neutron-irradiated semiconductors. Detectors utilizing these phenomena would be operative following an exposure to a neutron environment. Effects associated with radiation damage can be minimized by annealing the detectors before measuring electrical changes associated with radioactive decay. Neutron spectroscopy can be performed by using materials with different neutron-reaction cross sections. Detectors can be either homogeneous devices or junction devices and can be operated in modes to detect either individual pulses (radioactive decays) or integrated-pulse effects. Particular emphasis is given to detectors which are homogeneous devices operating in the pulse-integrating (induced conductivity) mode. High-resistivity semiconductors with large mobility-lifetime products are ideally suited for such detectors. This particular mode of operation has been demonstrated using CdS detectors exposed to fast-neutron fluences varying from 10^{11}–10^{17} neutrons/cm^2. (auth)

11812 A VIDICON SYSTEM FOR DIGITALISING FLASH TUBE INFORMATION FROM A MAGNETIC SPECTROMETER. Harrison, D. J.; Rastin, B. C. (Univ. of Nottingham, Eng.). Nucl. Instrum. Methods; 77: 181-8(1970).

A system for the automatic recording of particle trajectories through an array of neon flash tubes has been designed and constructed. This involves the use of a television channel employing a vidicon tube as the sensing element. Details are given of how the information has been coded, stored and finally produced in the form of computer compatible paper tape. The present system has been designed to work in conjunction with a magnetic spectrometer, although it is sufficiently versatile that after minor modification it can be used to record multiple particles through an array, for example in extensive air shower work, or trajectories of particles in spark chambers. (auth)

11813 A CYLINDRICAL SURFACE BARRIER DETECTOR FOR OPERATION IN A MULTI-GAP BETA-RAY SPECTROMETER. Gibbins, C. J.; Sareen, R. A. (Univ. of Liverpool). Nucl. Instrum. Methods; 77: 213-17(1970).

The construction of a cylindrical surface barrier detector for use in a seven-gap orange beta-ray spectrometer is described, and its performance is compared with that of the more commonly used plastic scintillator. The high energy resolution and low noise of the surface barrier detector result in a significant improvement in the peak-height to background ratio in measurements of prompt electrons from nuclei produced by neutron evaporation reactions. (auth)

11814 NEUTRON INELASTIC SCATTERING MEASUREMENTS WITH A GATED PHOTOMULTIPLIER. Fullwood, R. R.; Hockenbury, R. W. (Rensselaer Polytechnic Inst., Troy, N. Y.). Contract AT(30-3)-328. Nucl. Instrum. Methods; 77: 245-8 (1970).

Neutron inelastic scattering measurements have been made on iron samples from 0.8 to 15 MeV using a gated photomultiplier mounted on a NaI crystal. The transistorized gating technique may also be applied to other scintillation detector experiments where the accelerator beam flash would otherwise limit the experiment. (auth)

11815 VERSATILE LIQUID HELIUM SCINTILLATION COUNTER OF LARGE VOLUME DESIGN. Buckle, D. C.; Kane, J. R.; Orrick, B. D.; Siegel, R. T.; Wetmore, R. J. (Coll. of William and Mary, Williamsburg, Va.). Nucl. Instrum. Methods; 77: 249-53(1970).

A 3 liter liquid helium counter has been assembled and used in two experimental configurations. The operation of the scintillation chamber is described in terms of these experiments, and the pulse height and resolution characteristics of the counter are given for the case where two 5 in diam. phototubes view the liquid helium with good geometry. (auth)

11816 CHARACTERISTIC BEHAVIOR OF THE SPARK COUNTER. Prasad, Y.; Nath, N. (Banaras Hindu Univ., India). Nucl. Instrum. Methods; 77: 254-60(1970).

The quiescent corona discharge condition for the spark counter has been carefully investigated to explain some observed features concerning its counting behavior. The extension of the sensitive region about the wire anode has been experimentally determined. Optimum electrode separation for use in this detector has also been empirically determined. A new cylindrical design for this detector has been proposed and its usefulness is outlined. (auth)

11817 ANNULAR POLARIMETER FOR MEASUREMENTS OF NUCLEON POLARIZATION IN NUCLEAR REACTIONS. Oehler, H.; Krivopustov, M.; Schirmer, G.; Sisov, I. W.; Asfour, F. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Instrum. Methods; 77: 292-9(1970).

The method of the annular polarimeter for measuring the nucleon polarization in nuclear reactions is described in detail and its advantages against the usual left-right asymmetry method are shown. The calculations of the geometrical factor and the averaged analyzing power were carried out using the Monte-Carlo method. For an example the polarization of protons from the reaction $^{12}C(^3He,p_0)^{14}N(g.s.)$ at $E(^3He) = 2.87$ MeV was measured as a function of the scattering angle using the elastic scattering $^{12}C(p,p)^{12}C$ as an analyzer. (auth)

11818 A NOMOGRAM FOR THE DESIGN OF POSITION SENSITIVE SILICON DETECTORS. Kalbitzer, S.; Stumpfl, W. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Instrum. Methods; 77: 300-2(1970).

The charge dividing mechanism of a position sensitive detector can be understood by the simple model of a one dimensional RC-line. When this network is extended to the more realistic two dimensional case, the charge dividing properties are found to remain unaltered. It is shown that the positional information is correlated with the center of gravity of the initial charge distribution. The most relevant electrical parameters which determine resolution and ballistic deficit have been evaluated and are presented in a nomogram. (auth)

11819 DELAY-LINE READOUT FOR PROPORTIONAL CHAMBERS. Rindi, A.; Perez-Mendez, V.; Wallace, R. I. (Univ. of California, Berkeley). Nucl. Instrum. Methods; 77: 325-7(1970).

A simple method for locating the position of particles which produce ionizing events in proportional wire chambers is described. The method involves the use of ferrite-loaded delay cable. (auth)

11820 THE GAS PROPORTIONAL SCINTILLATION COUNTER UNDER X-RAY BOMBARDMENT: RESOLUTION AND PULSE CORRELATIONS. Policarpo, A. J. P. L.; Alves, M. A. F.; Carvalho, M. J. T.; Da Rocha, M. A. G. (Univ., Coimbra). Nucl. Instrum. Methods; 77: 309-14(1970).

The resolutions of a proportional scintillation counter ("pill box" geometry) with Xe and Xe−0.75% N_2 and the correspondent charge resolutions are measured for 5.9 keV X-rays. Typical values are 20% for the light pulses and 17.5% for the charge pulses. It is shown that there is a strong correlation between charge and light pulses, implying the same intrinsic resolution, in agreement with the mechanism of light production. The practical light output for the 5.9 keV x-rays was about the same as the light output of a NaI(Tl) crystal for the ^{137}Cs γ-rays. (auth)

11821 DETERMINATION OF THE GEOMETRICAL FACTOR OF CYLINDRICAL GEOMETRIES. Gillespie, C. R. (Louisiana State Univ., Baton Rouge). Rev. Sci. Instrum.; 41: 42-3(Jan 1970).

An approximation for the geometrical factor of cylindrical radiation detector geometries which converges rapidly is found. (auth)

11822 ON THE PREPARATION OF PLEXIGLASS LIGHT-GUIDES FOR SCINTILLATION COUNTER HODOSCOPE ELEMENTS. Dougan, P.; Kivikas, T.; Lugner, K.; Ramsay, W.; Stiefler, W. (Univ. of Lund, Sweden). Nucl. Instrum. Methods; 78: 317-18(1970).

A complete description is given of a method to prepare plexiglass light-guides for scintillation counter hodoscope elements. (auth)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 11813, 11836, 13008, 13311, 13348, and 13358.

11823 (BNWL-1276) MOESSBAUER EFFECT USING BACKSCATTER GEOMETRY AS APPLIED TO NONDESTRUCTIVE TESTING. Ord, R. N. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec 1969. Contract AT(45-1)-1830. 34p. Dep. CFSTI.

A Moessbauer effect spectrometer using a backscatter geometry has been developed which is capable of over 165% peak resonant signal to nonresonant background. This high percentage effect reduces the radiation counting time to minutes as compared to hours using conventional methods and leads the way to valuable nondestructive techniques. This improvement was achieved primarily by special shielding procedures and increased source intensity matched to an appropriate gas-filled proportional counter detector. Cobalt-57 is used as the source material; however, the technique can be applied to other Moessbauer elements. A number of spectra are shown for different applications in such fields as surface physics, geology, and metallurgy. (auth)

11824 (COO-1779-19) A NaI(Tl) SPLIT ANNULUS FOR COINCIDENCE, ANTICOINCIDENCE, TRIPLE COINCIDENCE, AND PAIR SPECTROMETRY. Kelly, W. H.; McHarris, Wm. C. (Michigan State Univ., East Lansing). [1968]. 9p. (CONF-690818-11). Dep. CFSTI.

From International Conference on Radioactivity in Nuclear Spectroscopy, Nashville, Tenn.

Examples of experiments using an 8 × 8-in. thallium-activated sodium iodide split annulus scintillation detector in anticoincidence and pair spectrometry are presented to illustrate the advantages and disadvantages of this system. (W.H.K.)

11825 A COUNTER FOR RESONANT SCATTERING ON ^{57}Fe. Oestergaard, P. (Technical Univ. of Denmark, Lyngby). Nucl. Instrum. Methods; 76: 358(1969).

A proportional counter is used in a scattering geometry to detect the x-rays following resonantly absorbed ^{57}Fe gamma-rays. (auth)

11826 SYSTEMS FOR THE STABILIZATION OF THE ROTATION RATE OF MECHANICAL NEUTRON SELECTORS. Golovin, A. E.; Tsitovich, A. P. (Inst. of Atomic Energy, Moscow). Prib. Tekh. Eksp.; No. 4, 127-31(Jul-Aug 1969). (In Russian).

Systems for stabilizing the rates of rotation of mechanical selectors that modulate neutron beams from reactors for experiments on the inelastic scattering of cold neutrons by matter are described. Three variations of systems for stabilizing the rotation rates are considered. The stability of the rates of rotation of ~0.2% was obtained. (tr-auth)

11827 COMPTON SPECTROMETER WITH AMPLITUDE SUMMING. Zaitsev, Yu. A.; Panteleev, L. I. (Inst. of Biophysics, Moscow). Prib. Tekh. Eksp.; No. 4, 36-9(Jul-Aug 1969). (In Russian).

A Compton spectrometer with amplitude summing is described. The main purpose of the spectrometer is the quantitative analysis of a mixture of gamma-active isotopes. The characteristics of the spectrometer are given, and in particular, the photofraction is given as a function of the energy of the gamma quanta. (tr-auth)

11828 ENERGY CONVERSION OF PULSE-HEIGHT SPECTRA OF GAMMA RADIATION MEASURED BY STILBENE CRYSTALS. Dvukhsherstnov, V. G.; Bakov, A. T.; Kazanskii, Yu. A.; Tarasko, M. Z. Prib. Tekh. Eksp.; No. 4, 39-41(Jul-Aug 1969). (In Russian).

The method of conversion to energy spectra of pulse-height spectra which were measured in the single-crystal scintillation gamma spectrometer with neutron discrimination is described. Examples of the treatment of pulse-height distributions of gamma rays from a ^{134}Cs and a Po + Be source are given. The data on the gamma transitions in ^{134}Cs are compared with previous data. (tr-auth)

11829 EXPERIMENTAL METHODS OF INVESTIGATING THE ALPHA RADIATION OF RADIOACTIVE NUCLEI. Baranov, S. A.; Kulakov, V. M. (Inst. of Atomic Energy, Moscow). Prib. Tekh. Eksp.; No. 4, 5-18(Jul-Aug 1969). (In Russian).

Experimental methods and equipment for the investigation of alpha radiation of radioactive nuclei are described, including the measurement of range-energy relationships, nuclear emulsions, spark chambers, scintillation spectrometers, and ionization chambers. The major emphasis is placed on semiconductor spectrometers and magnetic spectrometers. (tr-auth)

11830 EFFECT OF THE PULSE RATE AND SPECTRUM OF THE ENERGY SCATTERING POWER IN NUCLEAR SPECTROSCOPY. Schuster, H. J. (Physikalisch-Technische-Bundesanstalt, Brunswick). Nucl. Instrum. Methods; 78: 274-6(1970). (In German).

The decrease of the energy resolution in nuclear spectroscopy with a high pulse rate can be described by an additional fictitious parallel noise current depending on the pulse-rate and the spectrum. Directions for proper dimensioning of the input circuits are given. (auth)

11831 A COMPUTER PROGRAMME FOR THE DETERMINATION OF ACCURATE GAMMA RAY LINE INTENSITIES FROM GERMANIUM SPECTRA. Robinson, D. C. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods; 78: 120-4(1970).

A gamma ray analysis programme designed to produce accurate peak areas is described. It uses a line shape consisting of two Gaussians and an arctangent function together with a cubic background to provide a precise fit to full energy gamma ray peaks. The final error on the areas, after the whole fitting and background subtraction process, is only about twice the lower limit due to statistical fluctuations. The program is most suitable for the analysis of spectra containing only a few well resolved peaks. (auth)

11832 RADIOACTIVITY MEASUREMENTS BY THE $4\pi\beta-\gamma$ ANTICOINCIDENCE SPECTROSCOPY METHOD USING A Ge(Li) DETECTOR. Kawada, Y.; Yura, O.; Kimura, M. (Electrotechnical Lab., Tokyo). Nucl. Instrum. Methods; 78: 77-85(1970).

By the aid of a $4\pi\beta-\gamma$ anticoincidence set-up with a Ge(Li) detector, a method was developed which makes possible radioactivity measurements of some nuclides having complex decay schemes without requiring the decay scheme correction. The method employs the whole γ-spectra in both the γ- and anticoincidence-

channels, and the measurements are made according to the exact coincidence/anticoincidence principle. For examples of application of the method, measurements of ^{60}Co, $^{110m}Ag-^{110}Ag$ and ^{134}Cs are described and the results are compared with those obtained by other methods. Concerning the introduction of spectral information in the $4\pi\beta-\gamma$ technique, the advantages of the anticoincidence technique over the coincidence are pointed out with special reference to accuracy and precision. (auth)

11833 A DETECTOR SYSTEM FOR A ns-TIME-OF-FLIGHT EXPERIMENT WITH 3 MeV NEUTRONS FROM THE D(d,n)^{3}He NUCLEAR REACTION. Wiesner, K.; Truetzschler, K.; Schubert, D.; Neumann, R. (Technische Univ., Dresden). Nucl. Instrum. Methods; 78: 131-40(1970). (In German).

An efficient low threshold detector system with space charge discrimination for neutron time-of-flight spectrometry at a pulsed 500 kV-cascade-generator is described. The comparison between single-tube- and twin-tube-detector shows the advantages of the single-tube-arrangement. For neutron energies from 0.6 to 3.2 MeV the detection efficiency of a NE-213 liquid scintillator at a recoil proton energy threshold of 650 keV has been measured by n-p scattering in polyethylene with and without n-γ discrimination. The experimental results were compared with calculated efficiencies and a good agreement is obtained for the energy dependence as well as for the absolute values of the detection efficiency. The application of this detector system is demonstrated by both the neutron time-of-flight spectrometry of the ^{9}Be(d,n)^{10}B-reaction and n-p scattering in polyethylene. (auth)

11834 A COUNTER FOR RESONANT SCATTERING ON ^{57}Fe. Oestergaard, P. (Technical Univ. of Denmark, Lyngby). Nucl. Instrum. Methods; 77: 328(1970).

A proportional counter is used in a scattering geometry to detect the x-rays following resonantly absorbed ^{57}Fe gamma-rays. (auth)

High Energy Physics Instrumentation

Refer also to abstracts 12923 and 13260.

11835 (SLAC-103) FILMPLANE RECONSTRUCTION OF TRAJECTORIES IN A NONUNIFORM MAGNETIC FIELD: THE COMPUTER PROGRAM SYBIL. Fries, Dietrich E. C. (Stanford Linear Accelerator Center, Calif.). Dec 1969. Contract AT(04-3)-515. 36p. Dep. CFSTI.

The computer program SYBIL for analysis of streamer chamber pictures at SLAC is described. The program is designed to compute spatial track coordinates from film measurements by least square optimization of the geometrical parameters directly in the three film planes. (W.H.K.)

11836 SPARK CHAMBER SPECTROMETER FOR ELECTRONS AND PHOTONS. Gapotchenko, A. G.; Govorkov, B. B. (Inst. of Physics, Moscow). Prib. Tekh. Eksp.; No. 4, 33-5(Jul-Aug 1969). (In Russian).

The energy resolution of a multilayer spark chamber with plexiglass plates was studied. The resolution turned out to be practically independent of energy and equal to 30-35% for electrons in the range 60-150 MeV and 35% for photons in the energy range 100-150 MeV. (tr-auth)

11837 PROPERTIES OF SPARK CHAMBERS WITH LEAD ELECTRODES FOR RECORDING ELECTRONS AND PHOTONS OF HIGH ENERGIES. Zaitsev, A. M.; Radkevich, I. A.; Tomashchuk, Yu. F. (Inst of Theoretical and Experimental Physics, Moscow). Prib. Tekh. Eksp.; No. 4, 45-9(Jul-Aug 1969). (In Russian).

The properties of a spark chamber with lead electrodes with a total of 4 conversion gaps (11 electrodes) for recording electrons and photons were studied. The efficiency for detecting electron and photon events for electrons of 44, 144, and 234 MeV and photons of 50 and 100 MeV was obtained and the shower characteristics were compared with previous data. (tr-auth)

11838 THIN FOIL ELECTRODES FOR LARGE-DIMENSION SPARK CHAMBERS. Dukhovskoi, I. A.; Radkevich, I. A. (Inst. of Theoretical and Experimental Physics, Moscow). Prib. Tekh. Eksp.; No. 4, 49-50(Jul-Aug 1969). (In Russian).

The method for preparing thin film electrodes of 980 × 490 mm^2 for multigap spark chambers is described. (tr-auth)

11839 POWER SUPPLY OF STABLY OPERATING STREAMER CHAMBER. Rudenko, N. S.; Tsvetkov, V. I. (Tomsk Polytechnical Inst., USSR). Prib. Tekh. Eksp.; No. 4, 51-3(Jul-Aug 1969). (In Russian).

The power supply of the streamer chamber which permits one to obtain particle tracks of almost identical brilliance in both projections is described. The width of the short streamers was 3-5 mm. The operation of the streamer chamber was stabilized at the expense of the obtaining of high-voltage nanosecond pulses, stable in duration and identical across the whole length of the electrode plates. (tr-auth)

11840 ORGANIC GLASS FOR DETECTORS IN CHERENKOV COUNTERS. Rubtsov, M. A.; Frolova, M. I.; Chukin, V. S. Prib. Tekh. Eksp.; No. 4, 59-60(Jul-Aug 1969). (In Russian).

Data are given on the transparency of organic glass for use as detector material in Cherenkov counters. (tr-auth)

11841 INTEGRATED CHERENKOV DETECTOR FOR DETERMINATION OF SHORT PULSES OF ELECTRONS WITH ENERGY OF 8 TO 20 MeV. Gumanskii, G. A.; Kudin, V. I.; Tarutin, I. G. (Scientific Research Inst. of Oncology and Medical Radiology, Minsk). Prib. Tekh. Eksp.; No. 4, 60-1(Jul-Aug 1969). (In Russian).

The problems of using Cherenkov counters in the integrated mode for recording short pulses of electrons are examined. The characteristics of the detector were measured for streams of 10^5 to 10^7 electrons/cm^2 sec. (tr-auth)

11842 SYSTEM FOR REGISTRATION AND COMPUTER INPUT OF INFORMATION FROM A 32-WIRE SPARK CHAMBER. Barabash, L. S.; Grachev, A. G.; Komogorova, L. V.; Kondrashov, V. D.; Nikityuk, N. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp.; No. 4, 66-70(Jul-Aug 1969). (In Russian).

A system for registration and computer input of information from a 32-wire spark chamber having an operating range to 480 wires is described. The logic structure of the scheme permits the determination of the center of the track. The system was used with the standard high-speed computer BESM-ZM. (tr-auth)

11843 ON-LINE EVENT-FOLLOWING WITH COUNTER COMPUTER. Kontos, J.; Papakonstantinou, G. (Democritus Nuclear Research Centre, Athens). Nucl. Instrum. Methods; 78: 206-12(1970).

The feasibility of applying counter computers to the on-line recognition of tracks, stars and trees is demonstrated. The implementation of some event-following algorithm by counter computer systems is described and examples are given. The systems proposed were tested by software simulation that proved an extremely convenient and flexible tool. The possibility of utilizing memory multi-accessing in counter computer systems for reducing program size in recognizing trees of any complexity is also demonstrated. Counter computer systems may in some cases be capable of faster picture processing than classical single-accumulator systems. (auth)

11844 SOME ASPECTS OF THE DESIGN OF COSMIC-RAY MUON SPECTROMETERS. Bull, R. M.; Coates, D. W.; Milne, W. J.; Nash, W. F.; Woodham, R. E. (Univ. of Nottingham, Eng.). Nucl. Instrum. Methods; 78: 40-4(1970).

Cosmic-ray muon spectrometers are of considerable importance both as a means of investigating the natural beam for its own inherent interest and as a monitor for high energy muon interaction experiments. The advantages and disadvantages of multilayer and conventional solid-iron spectrometers are compared. (auth)

11845 A SEMICONDUCTOR DETECTOR TELESCOPE FOR IDENTIFYING MASS OR CHARGE OF HIGH ENERGY PARTICLES BASED ON THE MINIMUM PULSE HEIGHT SELECTION METHOD. Nagata, K. (Rikkyo Univ., Tokyo). Nucl. Instrum. Methods; 77: 219-28(1970).

A semiconductor detector telescope has been constructed to identify high energy singly charged particles. The telescope is based on the method of selecting the smallest of five pulses produced by a charged particle passing through five lithium-drifted silicon detectors of thickness 2.64 mm. Using a single detector of such thickness, pions are distinguishable from positrons in the momentum range only up to 160 MeV/c and protons from pions only up to 900 MeV/c, and the resolution is about 22% with minimum ionizing particles; while our detector telescope gives a resolution of about 11% and can distinguish pions from positrons and protons from pions up to 190 MeV/c and 1200 MeV/c, respectively. It is also proposed to use such a telescope comprising suitably thick detectors as a charge identifier for heavy primary cosmic rays. The estimated resolution is 1.2 units of charge, which is almost twice as good as the resolution of 2 units of charge for nuclear emulsions. (auth)

Radiation Dosimeters

Refer also to abstract 12193.

11846 (AECL-2714) THE EFFECTS OF ENERGY AND ANGULAR DEPENDENCE ON THE RESPONSE OF FILM, QUARTZ-FIBRE ELECTROSCOPE AND THERMOLUMINESCENT PERSONNEL DOSIMETERS. Scott, A. G. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Nov 1969. 23p. Dep. CFSTI (U. S. Sales Only). AECL $1.00.

Different types of dosimeters worn simultaneously in measured radiation fields provide differing exposure estimates. To determine how much of this is due to differing angular and energy dependence, film, electroscope and LiF personnel dosimeters were exposed on a phantom to photons with energies from 76 to 1250 keV from eight directions. The variation in response with energy and with angle of irradiation is presented. The probable variation between dosimeters in practice due to these effects is estimated to be approximately 20%. (auth)

11847 (RFP-1369) CRITICALITY DOSIMETRY FOR PLANT PERSONNEL. Boss, Merlyn R.; Mann, John R. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 26 Dec 1969. Contract AT(29-1)-1106. 16p. Dep. CFSTI.

The personnel criticality activation dosimeter in use at the Rocky Flats Plant is an integral part of the film badge and the thermal luminescent dosimetry (TLD) badge. The system consists of a copper foil, cadmium-shielded indium foil, unshielded indium foil, and a sulfur tablet. The nuclear reactions in use are ^{115m}indium, ^{63}copper (n,γ) ^{64}copper; and ^{32}sulfur (n,p) ^{32}phosphorus. These reactions cover the energy ranges: 0 to 1.4 electron volts; 2 electron volts to 1 million electron volts; 1 million electron volts to 2.9; and above 2.9 million electron volts. Fluence and dose calculations and the counting equipment are described. (auth)

11848 (SFL-A-13) ARRANGEMENT FOR READ-OUT OF LUMINESCENT DOSIMETERS. Toivonen, M. (Institute of Radiation Physics, Helsinki (Finland)). Jul 1969. 16p. Dep. CFSTI (U. S. Sales Only).

A reader for luminescence dosimeters is described. The equipment comprises separate heads for stimulating radiophotoluminescence and thermoluminescence and a common integrating unit for measurement of the photomultiplier output charge. The performance of the apparatus has been tested with phosphate glasses and with $Li_2B_4O_7$: Mn thermoluminescent powder. Furthermore the low dose performances with LiF: Cu, Ag and LiF: Mg, Ti luminophors have been investigated. (auth)

11849 COMMENTS ON PERSONNEL DOSIMETERS. Brady, William J. (Reynolds Electrical and Engineering Co., Inc., Mercury, Nev.). Health Phys.; 18: 91-3(Jan 1970).

Dosimetry materials are compared and the problem areas stated. Attention is drawn to the need for filter systems for evaluation of exposures to mixed radiations. Comments are made on the tests performed on personnel dosimetry services. (UK)

11850 APPARENT DISCREPANCIES IN RESULTS FROM A MAJOR COMMERCIAL SUPPLIER OF FILM BADGES. Crosby, E. H. (Guthrie Clinic Ltd., Sayre, Pa.). Health Phys.; 18: 93-4(Jan 1970).

Comparative figures are given from five medium sized hospitals using the same film badge service, for reported exposures from radiation above 100 keV (effective), among diagnostic radiology workers, although the majority of procedures in which they were concerned was below 100 KV peak and none above 120 KV peak. Similar chronological patterns have been noted in the periods 1966, 1967 and 1968 for each hospital. (UK)

11851 AN APPROXIMATION FOR ESTIMATING COMPTON SCATTER FROM A CUBOID PHANTOM. McEwan, A. C. (Cambridge Univ., Eng.). Phys. Med. Biol.; 14: 627-30(Oct 1969).

A simple approximation is outlined for calculating Compton scatter from phantoms of low atomic number. Reasonable agreement with experiment was obtained for radiations over a wide energy range, from ^{137}Cs γ-rays to 14 Mv x-rays, if the spectral distributions of the radiations were taken into account. (auth) (UK)

Radiometric Instruments

Refer also to abstract 11698.

11852 APPARATUS FOR CORRECTION OF GAMMA-GAMMA MEASUREMENT ON BORE-HOLE INFLUENCES. Aulepp, G; Steinbrecher, D. Z. Angew. Geol.; 14: 544-6(1968). (In German).

The principle of the correction device for γ-γ measurement requires brief discussion; the device calls for a two-channel probe with which 2 measurements at different probe lengths are recorded in the experiment. The 2 impulse rates then are functions of effective rock density, effective filter cake density, and the strength of the filter cake; knowledge of the functional dependence on rock density allows immediate extraction of this value. Application of the method through a correlation diagram (spine and ribs plot) is illustrated. There is greater advantage to the method under circumstances where the short-length probe impulse rate varies significantly more than the long-probe impulse rate. Applications to several measurements in East Germany are cited. (BBB)

11853 NEUTRON METER USE IN SOIL-MOISTURE MEASUREMENTS. REPORT OF A SURVEY CONDUCTED BY THE U. S. WORK GROUP ON NUCLEAR TECHNIQUES IN UNSATURATED AND SATURATED ZONES. Gardner, Wilford R. (Univ. of Wisconsin, Madison). Isotop. Radiat. Technol.; 7: 297-305 (Spring 1970).

The answers to a questionnaire sent to 350 persons from which 200 responded have been correlated to provide up-to-date information on the use of neutron meters in soil-moisture measurement. Commercial instruments are used chiefly, and the number in use increases steadily. Field calibration remains a difficult problem. The method is in use for every hydrological problem that requires a soil-moisture measurement. A real need exists for research and development to increase the reliability of the meters in field use. Two bibliographic lists are appended to illustrate the scope of the present work. (auth)

11854 A METHOD FOR THE NONDESTRUCTIVE DETECTION OF MOISTURE IN ROOF SANDWICHES. Lahmon, Ralph (Eastman Kodak Co., Rochester, N. Y.). Isotop. Radiat. Technol.; 7: 325-30(Spring 1970).

A nondestructive method for measuring the moisture content of sandwiched roofing material has been developed which enables a rapid inspection to be made without puncturing the roof. An instrument normally used to measure moisture content in soils was standardized for this application. Field testing showed the instrument to be capable of indicating areas of moisture invasion. The gage has been successfully used on several building roofs to locate and map areas that were seriously saturated with moisture. In a few cases it was used to relate the deterioration of the roof to age and to indicate where either replacement or resurfacing of certain roof areas was required. The gage will be used for troubleshooting, and savings of several thousand dollars a year are expected. A program is being developed in which the gage will be used routinely to inspect the roofing sandwiches. (auth)

11855 DETERMINATION OF THE THICKNESSES OF COATINGS BY MEANS OF ELECTRONS EXCITED BY A GAMMA SOURCE. Starchik, L. P.; Yuzhnyi, O. V. (Central-Asian State Univ., Tashkent). Prib. Tekh. Eksp.; No. 4, 198-9(Jul-Aug 1969). (In Russian).

A simple method for determining the thickness of thin coatings, the sensitivity of which increases with the difference between the atomic numbers of the coating and the substrate, is described. A table for determining the thicknesses of gold and aluminum on substrates of various atomic numbers is included. (tr-auth)

11856 SAFETY OF β-RAY THICKNESS GAUGE AND ITS STANDARDIZATION. Yoshizawa, Kenichi (Japan Electric Measuring Instrument Manufacturer's Ass., Tokyo). Genshiryoku Kogyo; 15: No. 10, 57-62(Oct 1969). (In Japanese).

In contrast to the medical field, the utilization of radiation for gages, instruments, etc. in industry fall somewhat behind because of rigorous regulations. It is possible, however, to promote the utilization by mitigating regulations for the users, if the strict regulations for the makers are established. In this connection, studies have been made on the safety of β-ray thickness gages by a group composed of makers, sales firms and also men of learning and experience. These studies were carried out for about three years, and the results are described. Also the standardization of the gage is referred to. Items described: possible accidents; degree of safety of sealed radiation sources; safety of source containers; test conditions for heat resistance, especially in a fire; preparation of draft technical criteria; experiment to confirm the safety; confirmation of the technical criteria; and standardization in JIS of industrial radiation instruments. (NSA of Japan)

11857 DEVICE FOR WARMING THE DETECTOR IN A RADIATION THICKNESS-METER. Moriya, Masatoshi (to Yokogawa Electric Works Ltd). Japanese Patent 1969-23554. 4 Oct 1969. Filed 24 Feb 1965.

When the thickness of objects is measured with a radiation thickness-meter, errors of a transient nature often occur due to the temperature difference between the object and the environment, viz. the detector. This transient error at the beginning of the measurement can be removed by the proposed method. The

device is applied to a radiation thickness-meter, which measures the thickness of objects by means of the combination of radiation source and ionization chamber; utilizing either penetrating or back-scattered radiation. Prior to the placement of an object to be measured between the radiation source and the ionization chamber, a plate, heated at the same temperature as the object, is inserted between the two, to warm up the ionization chamber to that temperature. Subsequently, the object is inserted in position, and the measurement is started. (NSA of Japan)

Miscellaneous Instruments and Components

Refer also to abstracts 12176, 13562, 13588, and 13614.

11858 (IA-1190, pp 271-303) FACILITIES, INSTRUMENTATION, AND METHODS. (Israel Atomic Energy Commission, Tel Aviv).

During the past year the Soreq On-Line Isotope Separator, SOLIS, became fully operational, marking an important advance in the program for studying short-lived fission products. A low energy electron gun was constructed, work was continued on the development of electrostatic analyzers, and a program was initiated for the development of a new magnetic resonance spectrometer. Computer methods were developed for the least squares analysis of discrete data points as obtained from a multichannel analyzer specifically adapted for the analysis of complex Moessbauer spectra and for the analysis of gamma spectra. Development of digital instrumentation built mainly of integrated circuits and designed for automatic control of experiments and adaptation of the data for computer processing is described. An on-line system incorporating a PDP-8 computer was installed and several other on-line systems are in an advanced stage of design. The Vacuum Technology Laboratory continued its work on the development of advanced methods and techniques for use in high vacuum and low temperature work. In addition, research on the basic mechanism of sealing was continued. Work was also carried out in the fields of glass technology, thin film techniques, and production of liquid nitrogen. (auth)

11859 (NUMEC-3292-13) CASCADE INSTRUMENTATION. Hoynacki, J. J.; Fersch, K. E. (Nuclear Materials and Equipment Corp., Lewiston, N. Y. Niagara Div.). 28 Nov 1969. Contract AT(40-1)-3292. 14p. Dep. CFSTI.

The new process control instrumentation package installed at the Boron Isotope Separation Facility is briefly described. (W.H.K.)

11860 (SC-TM-70-15) PROBLEMS USING MIE SCATTERING PHOTOMETERS FOR IN-PLACE HEPA FILTER TESTS AND AEROSOL STUDIES. Skillern, C. P. (Sandia Labs., Albuquerque, N. Mex.). Jan 1970. 25p. Dep. CFSTI.

Three commercially available instruments that use Mie light scattering were studied; two forward light scattering aerosol photometers, and a right-angle scattering particle counter. Standard calibration aerosols may be different from aerosols encountered at test locations, though made to appear similar by the instrument measurements. Modifications to the right-angle scattering particle counter, necessary to adapt it to the high dust loadings in studies other than aerosol-free environments, cause substantial errors in the measured particle size distribution. Frequent checking by optical and electron microscopy is essential to identify the actual particle-size distribution of the aerosol. (auth)

11861 INSTRUMENT FOR STUDYING LOW FREQUENCY INTERNAL FRICTION AT CONSTANT AMPLITUDE IN IRRADIATED FOILS. Harbottle, J. E. (Berkeley Nuclear Labs., Eng.). J. Phys., E (London); 3: 49-54(Jan 1970).

An apparatus was designed and developed to study low frequency internal friction in neutron irradiated foils in the temperature range 77-300°K. The pendulum is specifically designed to have a single mode of oscillation with negligible dissipation of energy at higher parasitic frequencies. It is driven automatically and the amplitude is maintained constant by a controlled gain positive feedback loop from which a continuous recording of internal friction of the specimen is obtained. A typical example of the damping of neutron irradiated pure iron is given, showing a complex peak in the temperature region 200 to 240°K. (auth) (UK)

11862 STUDY ON PERMANENT-MAGNET FLOWMETER FOR LIQUID SODIUM. 2. EXPERIMENT. Kobayashi, Kiyosi; Kudo, Akio (Tohoku Univ., Sendai). Nippon Genshiryoku Gakkaishi; 11: 716-20(Dec 1969). (In Japanese).

Experimental results obtained on a liquid sodium electromagnetic flowmeter are described. Using a calibrating loop, the performance of the electromagnetic flowmeter was measured in terms of flow rate, sodium temperature (200 to 500°C) and of sodium purity. The flowmeter output calculated in the previous report was in good agreement with the experiments. (auth) (NSA of Japan)

11863 MASS SPECTROMETER. Omura, Ichiro (to Hitachi Ltd.). Japanese Patent 1969-23588. 4 Oct 1969. Filed 11 Sep 1961.

In the mass spectrometer proposed, the two different mass spectra, corresponding to negative and positive ions, can be obtained easily in a single apparatus. Two ion collectors for negative and positive ions respectively are placed in symmetric positions after a deflecting magnetic field. The accelerating voltage of the ion source is switched alternately with regard to positive or negative sign. Thus, negative and positive ions are sent in the same direction into the magnetic field, where they are deflected into the respective ion collectors. (NSA of Japan)

11864 PORTABLE LEAK DETECTOR. Toyota, Minoru (to Daikin Kogyo Co.). Japanese Patent 1969-20640. 3 Sep 1969. Filed 3 Jul 1961.

The leak detector proposed, which is applicable for detection of halogens or halides, has the following advantages: small size, no need for heating, safe operation, and high sensitivity. The principle used is ionization of the gas and observation of the subsequent electrical pulses. The detector is made in the form of a pistol, so that it is portable and easy to handle. The gas inlet is at the muzzle and along the barrel a passage for the gas to be detected is provided; a fan driven by a motor draws in the gas. Two electrodes, i.e., cathode and anode, in the shape of oblong plates are set opposing each other, along and on the inside surface of the gas passage. Some radioisotope is attached on one of the two electrodes. An amplifier, consisting of a vacuum tube and transistors, is connected between the two electrodes; and voltage of about 100 V/cm is applied between the two electrodes. For the detection of leaked gas, the gas entering the passage is ionized and the change in pulsed current between the electrodes is observed. (NSA of Japan)

11865 PULSE POWER SUPPLY FOR PHOTOMULTIPLIERS. Vorobev, V. V.; Chernov, N. I. Prib. Tekh. Eksp.; No. 4, 151-2 (Jul-Aug 1969). (In Russian).

The operation of FEU-30 and -52 with a pulsed power supply was studied. The maximum exit current of 12 amp for a voltage of 10 kV was obtained for FEU-52 (tr-auth)

11866 TEMPORAL FLUCTUATIONS OF PULSES FROM FEU-36. Kanavets, V. P.; Morozov, B. V.; Nikiforov, N. A.; Potapov, N. I.; Starostin, A. S. Prib. Tekh. Eksp.; No. 4, 157-60(Jul-Aug 1969). (In Russian).

FEU-36 was studied using a pulsed source of light and a beam of relativistic π^- mesons with a plastic scintillation of 15 mm thickness. The upper limit of the distribution of the temporal variations of FEU-36 was found to be close to 0.2 nsec. Information is given on the null level detector and the fast coincidence scheme used in the work. (tr-auth)

11867 THREE-MIRROR INTERFEROMETER FOR PLASMA DIAGNOSTICS IN TRANSPARENT GAS-DISCHARGE TUBES. Bakeev, A. A.; Rovinskii, R. E.; Cheburkin, N. V. Prib. Tekh. Eksp.; No. 4, 166-7(Jul-Aug 1969). (In Russian).

An improved three-mirror laser interferometer for measuring the parameters of plasma in transparent tubes with small internal diameter and without special windows for the passing of the laser ray is described. (tr-auth)

11868 A METHOD OF ELECTRON MICROPROBE SIGNAL ENHANCEMENT BY PULSE RATE ANALYSIS. Reid, L. R.; Smith, J. P. (Texas Instruments Inc., Dallas). Rev. Sci. Instrum.; 41: 26-8(Jan 1970).

A means of signal processing specifically designed for use with electron microprobe analyzers is described. The method of "pulse rate analysis" (PRA) can, however, be applied to many areas of data gathering and signal processing where it is desired to suppress randomly distributed background noise pulses. A variable rate control allows selection of the incoming pulse rate required to produce an output signal at the display unit. The pulse rate range has been optimized for microprobe work and covers a PRF of 10 Hz to 40 kHz. A binary scaling arrangement extends this range by a factor of 2 or 4 while providing an S-fold interval distribution. Improvement of up to 50:1 has been observed in the apparent signal-to-noise (S/N) ratio. (auth)

11869 A SURVEY OF SOME SECONDARY THERMOMETERS FOR POSSIBLE APPLICATIONS AT VERY LOW TEMPERA-

TURES. Rosenbaum, Ralph L. (Univ. of California, San Diego, La Jolla). Rev. Sci. Instrum.; 41: 37-40(Jan 1970).

A survey has been made on the temperature dependent behavior of several new types of carbon resistors and germanium sensors to determine whether any particular type might be suitable as a secondary thermometer in the 0.01–1.0 K temperature interval. Each thermometer was specially constructed to improve the thermal contact to the sensing element. Several commercial germanium and carbon resistance sensors appear promising as thermometers in the very low temperature interval. In addition, it appears feasible to extend the use of 0.02 at. % Au–Fe thermocouples down to 0.05 K. (auth)

11870 DIFFERENTIAL GENERATING VOLTMETER. Polga, T.; Sala, O.; Douglas, R. A. (Univ., Sao Paulo, Brazil). Rev. Sci. Instrum.; 41: 15-17(Jan 1970).

A differential generating voltmeter was developed to operate with the electrostatic accelerator of the Universidade de São Paulo. It has an energy spread of 0.2% for 1 MeV protons. The calibration reproducibility of the system is 0.15% over all the accelerator voltage range and for a time period of eight months. The linearity of the energy calibration curve is 0.1% over the whole voltage range of the accelerator. (auth)

11871 PULSED GRID MODULATION SCHEME FOR AN ION CYCLOTRON RESONANCE SPECTROMETER. McIver, Robert T. Jr. (Stanford Univ., Calif.). Rev. Sci. Instrum.; 41: 126-7 (Jan 1970).

A pulsed grid modulation scheme which may be incorporated simply and inexpensively into an ICR-9 spectrometer is described. The grid is inserted in a section milled from the back side of a boron nitride filament mounting block. In order for an ICR signal to be registered, the ionizing electrons emitted from the filament must pass through a 1 mm diam hole in the grid before entering the ionizing region of the ICR cell. By suitably pulsing the bias on this grid, it then becomes possible to admit electrons or block their entry into the cell. (W.H.K.)

11872 GONIOMETER FOR ULTRAHIGH VACUUM ION IMPLANTATION. Jacobowitz, L. (New York Univ., Bronx). Rev. Sci. Instrum.; 41: 127-8(Jan 1970).

The development of a compact goniometer possessing two angular degrees of freedom, incorporating a substrate heater, which is suitable for hot ion implantation studies in an ultrahigh vacuum environment, is discussed. (W.H.K.)

11873 CROSSED-COIL PROBE FOR USE IN SUPERCONDUCTING SOLENOIDS. Mock, J. B. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Rev. Sci. Instrum.; 41: 129-30(Jan 1970).

A crossed-coil nuclear induction probe for use with small superconducting solenoids in the frequency range of 30 to 60 MHz is described for NMR spectroscopy. (W.H.K.)

11874 MAGNET CONTROLLER FOR A TYPE 103 MASS SPECTROMETER. Pancirov, R. J.; Huber, F. C.; Kelliher, J. M. (Esso Research and Engineering Co., Linden, N. J.). Rev. Sci. Instrum.; 41: 130-1(Jan 1970).

The use of a Varian Associations FR-4 controller gaussmeter in the magnet controller circuit for a CEC 21-103 mass spectrometer is described. (W.H.K.)

11875 PROGRAMMABLE IMPULSE GENERATOR FOR SPIN–LATTICE RELAXATION TIME MEASUREMENTS IN HIGH RESOLUTION NMR. LaLanne, P.; Eletr, S. (Faculte des Sciences, Bordeaux). Rev. Sci. Instrum.; 41: 71-3(Jan 1970).

The design of a precision, programmable impulse generator capable of producing repetitive impulse trains of accurately defined parameters, selectable over a wide range is described. The generator was conceived for the specific purpose of gating the audio modulation of the applied magnetic field in an HA 100 Varian NMR spectrometer. The basic circuit is much more general, however, and may be used for the generation of a wide variety of impulse trains. The present configuration is capable of producing repetitive trains of one π pulse followed by several equidistant 2π pulses. The width of these pulses, their number, their separation, and the repetition rate of the sequence are independently selectable. The selections may be made manually or by remote control from an on-line digital computer. All times are increments of a basic clock period, derived in our case from the 16.7 MHz crystal oscillator of the spectrometer. Construction is modular and TTL integrated circuits are used throughout for simplicity. (auth)

11876 THE USE OF TEMPERATURE INDICATING MATERIALS IN HIGH LEVEL RADIATION FIELDS. Groening, H.; Parker, W.; Rada, G. (Instituto Venezolano de Investigaciones Cientificas, Caracas). Nucl. Instrum. Methods; 78: 258-60(1970).

Surface temperature indicator strips have been used for measuring in-pile temperatures. The indicators made use of in the present work were subject to several radiation doses under various conditions without any apparent radiation damage. Temperatures recorded were accurate to within ±1% as compared to readings taken with thermocouples. It was concluded that the indicators can be used for registering temperatures inside nuclear reactors during full power operation. (auth)

11877 SIGNAL TRANSMISSION LINE WITH LOW ATTENUATION AND WIDE FREQUENCY PASSBAND. Porges, K.; Corwin, W.; Burkel, L.; Lewandowski, E. (Argonne National Lab., Ill.). Rev. Sci. Instrum.; 41: 138-9(Jan 1970).

The design and performance of a rigid transmission line for very fast signals from accelerator or reactor experiments are described. The transmission line consists of an outer conductor made from 2.54 cm o.d., 0.813 mm wall tubing and an inner conductor of 0.953 cm o.d. tubing. The space between inner and outer conductor is Styrofoam. Tapered matching pieces at each end accommodate GR-874 connectors. (W.H.K.)

11878 GENERATION AND SPECTROSCOPY OF ULTRASOFT X-RAYS BY NON-DISPERSIVE METHODS. Srdoc, D.; Clark, B. C. (Columbia Univ., New York). Nucl. Instrum. Methods; 78: 305-13(1970).

A number of conventional techniques used to generate soft x-rays can be successfully applied to the ultrasoft region (100 eV to 1000 eV). In this work, fluorescent radiation and selected radioisotope sources were employed and a miniature x-ray tube was designed for generating characteristic x-rays from various targets. A new method has been developed for producing a nearly monochromatic ultrasoft x-ray beam by heavily filtering bremsstrahlung radiation. A proportional counter has been used to measure the ultrasoft x-rays generated by the different methods. When the internal gas multiplication is not excessive, a linear relationship between the photon energy and the mean pulse height is found over the range of measurement 158 eV to 5890 eV. (auth)

11879 SIMPLE SYSTEM FAULT INDICATOR. Lavoie, L. (Univ. of Chicago). Nucl. Instrum. Methods; 78: 11-12(1970).

A simple closed series circuit that indicates instrument failures for use in high-energy physics experiments is described. (W.H.K.)

11880 REDUCTION OF PROCESSING LOSSES IN ON-LINE OR OFF-LINE ACQUISITION OF RANDOM COUNTS AT HIGH RATES. Porges, K. G.; Rush, C. J.; Caya, G. E. (Argonne National Lab., Ill.). Nucl. Instrum. Methods; 78: 115-19(1970).

Experiments in which random events are counted at rapidly varying event rates are subject to dead time errors which cannot be readily corrected. Such losses can be minimized, however, through the use of a fast prescaler or distributor. The dead time loss for prescalers and distributors is calculated, under very general assumptions, and a practical prescaler is described. (auth)

11881 HIGH RESOLUTION TIME-TO-AMPLITUDE CONVERTER. Balaux, N.; Boulay, R. (Univ. of Laval, Quebec). Nucl. Instrum. Methods; 78: 109-14(1970). (In French).

A time-to-pulse height converter of the Start-Stop variety is described. The circuit can accept high counting rates at both inputs and the dead time losses are limited only by the number of conversions per second. The intrinsic resolution is 2.8×10^{-12} sec. (auth)

11882 MULTICHANNEL TIME ANALYZER. Sentis, G.; Van Zurk, R. (CEN, Grenoble, France). Nucl. Instrum. Methods; 78: 154-60(1970). (In French).

A four channel time-to-amplitude converter designed to be used in multi-angle time of flight experiments is described. The range can be varied between 50 ns and 1 μs. Typical resolution time (^{60}Co) without timing circuit is 1.6 ns, while electronic resolution time is 90 ps. The design of the circuit allows the number of channels to be easily extended. (auth)

11883 REFLEX VERNIER CHRONOTRON. Aveynier, J.; Van Zurk, R. (CEN, Grenoble, France). Nucl. Instrum. Methods; 78: 161-70(1970). (In French).

The principle of a new time intervals analyzer of the Vernier chronotron type, measuring the time interval between two pulses occurring on the same input is described. The parameters limiting electronic resolution time and range are briefly analyzed. An electronic resolution time of 8 ps is obtained with a channel width of 1 ps in the best case. (auth)

11884 CIRCUIT FOR SYNCHRONIZATION TO 100 MHz WITH SHORT RESTORATION TIME. Alexander, B.; Bernard, P.; Riou, C. (CEN, Grenoble, France). Nucl. Instrum. Methods; 78: 171-2(1970). (In French).

A circuit which synchronises to 100 MHz clock signals, random pulses with an input rate up to 10^8/s, is described. (auth)

11885 MEASUREMENT OF PHOTON EMISSION DUE TO ATOMIC REARRANGEMENT FOLLOWING NUCLEAR DECAY. Schambeck, W.; Andrae, H. J.; Luchner, K. (Technische Hochschule, Munich). Nucl. Instrum. Methods; 78: 95-101(1970).

An apparatus for the detection of single photons (2–5 eV) is described. Low noise cooled photomultipliers are used, the amplitude spectrum of which is measured with incident low intensity light (single electron peak); it is compared with the noise spectrum. A tunneldiode discriminator for the standardization of the photomultiplier pulses and the determination of its optimum threshold is described. The quantum efficiency of the photomultipliers used is about 25%, the following electronic circuitry has a detection efficiency of almost 100%. The effect of noise background is decreased by the application of the coincidence method. For this purpose an atomic relaxation process is used: Delayed single photons are emitted after atomic adaption to the new nuclear charge following a β^--decay. The coincidence signals and their mutual delay (optical lifetime) are measured by means of a time to pulse height converter of the start-stop-principle and a multichannel analyzer. The time resolution of the fast-fast circuit alone is 6 nsec. The excitation of the daughter-ion is primarily due to the sudden change of nuclear charge; excitation by direct collision with charged particles can be neglected. The relative intensities of three emission lines and the lifetimes of the two $5p(^1/_2\ ^1/_2\ 0) - $ and $5p(^3/_2\ ^3/_2\ 0) - Rb^+$-states populated by the ^{85}Kr-decay are measured as a function of krypton-gas pressure. The undisturbed lifetimes of these states are measured to be $\tau_0 = 8.0 \pm 0.6$ nsec and $\tau_0 = 9.4 \pm 0.4$ nsec, respectively; the corresponding cross-sections for deexciting collisions ($Rb^{+*} - Kr$) are $\sigma^* = 5.5 \pm 0.6 \times 10^{-15}$ cm^2 and $\sigma^* = 4.8 \pm 0.5 \times 10^{-15}$ cm^2. (auth)

11886 INEXPENSIVE CURRENT INTEGRATOR USES IC MODULES. Hardy, W. R.; Yager, R.; Shewchun, J. (McMaster Univ., Hamilton, Ont.). Nucl. Instrum. Methods; 77: 331-2 (1970).

A current integrator which has a range of 10^{-3} to 10^{-9} A is described. (auth)

11887 DIFFERENTIAL LINEARITY TESTING AND PRECISION CALIBRATION OF MULTICHANNEL TIME SORTERS. Cova, S.; Bertolaccini, M. (Politecnico, Milan). Nucl. Instrum. Methods; 77: 269-76(1970).

The analysis of complex time spectra with many different components, extending over various time ranges of a time sorter, requires an accurate knowledge of the differential linearity of the instrument for each time range and of the ratios of the absolute calibrations for the different ranges employed. The requirements for accurate differential linearity measurements of multichannel time sorters are therefore discussed, and it is shown that these measurements can be practically done in reasonable counting times and employing standard laboratory instrumentation. Methods for absolute calibration are also considered, and a technique which is accurate and suitable for routine use is examined in detail. (auth)

11888 LONG-LIVED HIGH-FIELD PULSED MAGNET ADAPTABLE TO EXPERIMENTAL REQUIREMENTS. Dahl-Jensen, E. (CERN, Geneva); Doble, N. T.; Herz, A. J.; Casanova, A.; Gailloud, M. Nucl. Instrum. Methods; 77: 235-41(1970).

A pulsed-transformer (flux-concentrator) magnet has been built and used in which the high-field region can be shaped according to experimental requirements. Access to the high-field region is easily provided both parallel to the field direction and in a plane normal to it. The design is such that the magnet can be dismantled completely, repaired or modified, and reassembled, even after having been operated for several thousand pulses. Two such magnets have been used in an experiment to measure the magnetic moment of the Λ° hyperon; each produced 200 kG in a volume of 200 cm^3 for about 5000 pulses and is still in usable condition. (auth)

11889 CAPSULE FOR LENGTH CHANGE RECORDING DURING IRRADIATION OF FISSIONABLE SAMPLES. Lungu, S.; Rybko, L. (Inst. for Atomic Physics, Bucharest). Nucl. Instrum. Methods; 77: 210-12(1970).

Details of design and construction of a capsule for length change continuous recording during irradiation of fissionable samples with specific power up to 500 W/cm^3 are described. Length changes of 0.5–1% can be recorded with an accuracy of 0.006–0.012%. (auth)

11890 FEEDBACK CIRCUIT FOR GENERATION OF rf HIGH AMPLITUDE TRAVELING WAVES. Buschbeck, W. (AEG-Telefunken, Ulm, Ger.); Nielinger, H.; Richter, F.; Tuczek, H. Rev. Sci. Instrum.; 41: 94-7(Jan 1970).

For the investigation of the interaction between traveling magnetic fields and plasma it is necessary to excite long wave trains with high amplitudes on transmission lines. A special feedback circuit is described which permits generation of these wave trains with a relatively economical power supply. Field amplitudes of 2 kG at 1 MHz can be excited for pulse times of several milliseconds, using a 5 MW pulsed transmitter by reinjecting the output energy of the line at the input. The transient phenomena which depend upon the line losses and on a special method of self-excitation of the transmitter are calculated. (auth)

11891 SINGLE ELECTRON PULSE HEIGHT DISTRIBUTION OF PHOTOMULTIPLIERS. Sandor, T. (Louisiana State Univ., Baton Rouge). Nucl. Instrum. Methods; 78: 8-10(1970).

The single electron response of twelve RCA 8055 and three RCA 6341A photomultipliers have been investigated by measuring the pulse height distribution of the dark current pulses of the respective tubes. A peaked distribution was found in the case of the RCA 8055, while the other type resulted in a monotonically decreasing distribution which was closely exponential. (auth)

Radiation Effects on Instruments and Instrument Components

Refer also to abstract 11861.

11892 (RN-S-529) EVALUATION OF TEST RESULTS FOR THIN-FILM PRESSURE TRANSDUCER. NERVA PROGRAM. Final Report. Sita, E. R. (Aerojet-General Corp., Sacramento, Calif. Nuclear Div.). Sep 1969. Contract SNP-1. 73p. Dep. CFSTI.

Four, vapor-deposited, thin-film pressure transducers were irradiated in the ASTR 23/R512 test fixture, that simulated the NERVA engine mounted configuration. The test was conducted to determine the effects of gamma-rate and neutron damage on the performance characteristics of the test transducers, with radiation levels in excess of anticipated full-power engine requirements. The transducers used in the experiment were Statham Model PA812 (P/N 50390-1). Several secondary experiments were included in the test. These experiments included evaluating the effect of a variable gamma flux on stainless-steel-sheathed magnesium-oxide insulated cables, of the type used with the transducers, and verification of the analytical thermal model of the transducer. It was found that generally, radiation-induced changes in transducer characteristics are small. Significant changes are the gamma-induced zero shift and the neutron threshold damage level, both of which can be optimized by proper selection of the transducer TCR value. (W.H.K.)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Basic Processes

Refer also to abstracts 11484, 11963, 12072, 12169, and 12194.

11893 (UCSD-10-P-20-52(Pt.2)(Vol.2)) RESEARCH ON THE MARINE FOOD CHAIN. PROGRESS REPORT, JULY 1968–JUNE 1969. PART II. MANUSCRIPT REPORTS OF WORK CONCLUDED. VOLUME 2. ZOOPLANKTON AND PHYTOPLANKTON. Strickland, John D. H. (California Univ., La Jolla. Inst. of Marine Resources). Contract AT(11-1)-Gen-10. 372p. (IMR-69-9(Pt.2)(Vol.2)). Dep. CFSTI.

Major taxonomic groups of the micro-zooplankton populations were identified and their numerical abundance determined in several depth intervals over the upper 100 or 200 m from coastal, continental shelf, and oceanic sites in the northeastern Pacific Ocean. The filtering rates of the copepod, Calanus helgolandicus, were measured on synchronously growing populations of the diatom, Ditylum brightwellii. Measurements were made by following changes in cell numbers and by measuring the ingestion of ^{14}C labeled cells at selected intervals during two-day periods. Results indicated that there was no innate diurnal feeding rhythm in the copepods. Other studies included distribution, morphology, and seasonal biology of copepods; abundance of micro-zooplankton relative to larger zooplankton; and numerical abundance and estimated biomass of micro-zooplankton. Studies on phytoplankton included content of nitrate reductase in marine phytoplankton; amounts of DNA and organic carbon in single cells; a ciliate red tide at Barrow, Alaska; uptake of nitrate and ammonium by marine phytoplankton; salinity induced changes in growth, pigment, and cyclohexanetetrol content of Monochrysis lutheri; estimates of phytoplankton crop size, growth rate, and primary production; and relation of phytoplankton species distribution to the depth distribution of nitrate. (H.L.W.)

11894 CYTOKINETIC ANALYSIS OF SLOWLY RENEWING BONE-MARROW CELLS AFTER ADMINISTRATION OF NITROGEN MUSTARD. Haas, R.; Fliedner, T. M.; Stehle, H. (Univ., Ulm, Ger.). pp 205-20 of Effects of Radiation on Cellular Proliferation and Differentiation. Vienna; International Atomic Energy Agency (1968).

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco. See STI/PUB-186; CONF-680413.

The continuous or repeated administration of tritium-labeled thymidine (TT) into pregnant rats during organogenesis provides a method for the complete labeling of newborn rats. If these are continuously injected with TT for the first four weeks after birth, the fraction of labeled cells of all organs and cell-renewal systems is still 100%. If completely labeled animals are sacrificed at regular intervals after the discontinuance of thymidine administration, one can distinguish two groups of cells with distinct differences in their cell renewal. While the reticular cells A and B, the endothelial cells, and the bone-marrow lymphocytes belong to a slowly proliferating group of cells, the differentiated myelopoietic and erythropoietic cells of the bone marrow proliferate rapidly. That labeled erythropoietic or myelopoietic cells are not found later than 6 to 10 days after discontinuance of TT injection in these animals argues strongly against the hypothesis that under normal steady-state conditions a G_0 fraction exists in the bone-marrow, from which stem cells are deviated into the differentiated cell pools by adequate stimuli. The administration of nitrogen mustard in a dose sufficient to cause bone-marrow aplasia neither destroys nor stimulates the reticular cells and endothelial cells of the bone-marrow matrix. These cells retain their label and remain present in normal numbers throughout the period of observation after nitrogen mustard treatment: The only cell type in the marrow that changes its labeling intensity after nitrogen mustard administration is the marrow lymphocyte. The decrease in the fraction and intensity of labeled bone-marrow lymphocytes precedes the rapid regeneration of nitrogen mustard aplastic bone-marrow. This cell type, in our opinion, would be the only cell to qualify as a stem cell, although positive evidence is still lacking. (auth)

11895 PROLIFERATION AND DIFFERENTIATION OF NORMAL AND LEUKAEMIC HAEMOPOIETIC CELLS. Gavosto, F.; Pileri, A.; Gabutti, Vilma (Univ., Turin). pp 275-81 of Effects of Radiation on Cellular Proliferation and Differentiation. Vienna; International Atomic Energy Agency (1968).

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco. See STI/PUB-186; CONF-680413.

The following points are reported and discussed in connection with studies of normal and leukemic hemopoietic tissue proliferation and differentiation; defective differentiation in leukemia cells and their proliferation characteristics; acute leukemia blast populations as the result of an association of proliferating and non-proliferating cells: evaluation of the growth fraction and attempted calculation of the generation times of proliferating blasts; research into the possible feeding mechanisms of proliferating blasts (leukemic stem cells); differentiating erythroblast kinetics as a term of comparison in acute leukemia blast proliferation; RNA metabolism in differentiating hemopoietic cells and in acute leukemia cells. (auth)

11896 CYTOKINETIC CONTROL MECHANISMS IN EHRLICH ASCITES TUMOUR GROWTH. Lala, P. K. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 463-74 of Effects of Radiation on Cellular Proliferation and Differentiation. Vienna; International Atomic Energy Agency (1968).

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco. See STI/PUB-186; CONF-680413.

Ehrlich ascites tumor in mice was studied as a model system to elucidate the cytokinetic mechanisms controlling growth of cell populations. The basis for a retardation in growth rate during tumor development was determined with the aid of ^{3}H-thymidine labeling and autoradiography. Three possible cytokinetic variables in growth regulation, namely, duration of the mitotic cell cycle, fraction of the cycling cells in the population (growth fraction), and rate of cell loss, were measured at different stages of growth. It was concluded that a deceleration in growth was a result of a gradual prolongation of the cell cycle and its components and a progressive decline in the growth fraction. Rate of cell loss did not appreciably change during most of the growth. It was also found that the total cell mass rather than the tumor age dictated the growth rate at any instant over a considerable range of growth. Non-cycling cells were found to resume cycle when a fraction of an old tumor was transplanted in new hosts. ^{3}H-thymidine labeling combined with microspectrophotometric estimates of cellular DNA was utilized to locate the stages at which a cell cycle could be suspended or resumed. It was found that decycling or recycling could occur only after mitosis and before DNA synthesis; non-cycling (G_0) state resembled G_1, which was absent in the proliferating tumor cells. These findings are relevant to a further understanding of the molecular events leading to the initiation or suspension of a cell cycle. They are also pertinent to formulating a rationale for tumor therapy—for example with radiation—when coupled with the existing knowledge of the relative sensitivity of cells at different stages of cycle. (auth)

11897 PREDICTION OF DOSE DUE TO AN INTERNAL RADIOISOTOPE BY APPLICATION OF THE OCCUPANCY PRINCIPLE. Gillespie, F. C.; Orr, J. S. (Western Regional Hospital Board, Glasgow). Phys. Med. Biol.; 14: 639-44(Oct 1969).

Expressions are derived from the occupancy principle to describe tissue doses due to an internal radioisotope when a stable equivalent of the isotope forms part of the diet. The expressions are in terms of the dietary intake and tissue content of mother substance, the local energy deposition per disintegration and, in some cases, the physical half-life of the isotope. (auth) (UK)

11898 IMPROVED RADIOBIOASSAY OF URINE FOR TRITIUM. Moghissi, A. A.; Lieberman, R.; Carter, M. W.; Regnier, J. E. (Southeastern Radiological Health Lab., Montgomery, Ala.). Health Phys.; 17: 727-8(Nov 1969).

Tritium assay in urine for determination of body burden is carried out in many laboratories on a large scale. A variety of procedures has been proposed for liquid scintillation counting. Dioxane-based solutions appear to be the most frequently used mixtures. Suspension counting techniques using Triton X-100 as the detergent have been proposed. The authors evaluated a large number of detergents for low-level tritium counting in water and found that Triton N-101 may be applied for the counting of aqueous and quenched samples with favorable results. (UK)

11899 METABOLISM OF ^{3}H-11-DEOXYCORTICOSTERONE AND 4-^{14}C-11β-HYDROXYPROGESTERONE BY RAT ADRENAL

PREPARATIONS. Tsang, C. P. W.; Stachenko, J. (McGill Univ., Montreal). Can. J. Biochem.; 47: 1109-13(Dec 1969).

When equimoles of 4-^{14}C-11β-hydroxyprogesterone and 1,2-^{3}H-11-deoxycorticosterone are incubated with rat adrenal quarters for 3 h, they are incorporated to the same extent into corticosterone or aldosterone. The addition of an NADPH-generating system increases the incorporation of ^{3}H-11-deoxycorticosterone by two-fold, and that of 11β-hydroxyprogesterone by 1.6-fold. In a dilute homogenate supplemented with NADPH, only ^{3}H-11-deoxycorticosterone was utilized as precursor of these steroids. These studies demonstrate the capacity of rat adrenal sections to hydroxylate 11β-hydroxyprogesterone to corticosterone. The fact that a dilute homogenate does not utilize 11β-hydroxyprogesterone is related to the inhibition or inactivation of 21-hydroxylase activity. (auth) (Canada)

11900 SIMPLIFIED TECHNIQUE FOR THE APPLICATION OF NUCLEAR EMULSION IN ELECTRON MICROSCOPIC AUTORADIOGRAPHY. Bourne, V. L.; Cole, K. (Univ. of British Columbia, Vancouver). Can. J. Bot.; 47: 1821-2(Nov 1969).

A modified rotating disc technique for the application of nuclear emulsion in electronmicroscopic autoradiography under yellow-green safelight illumination was tested. It is simpler than a previous method and should produce better resolution, as the emulsion is applied directly over carbon-coated specimens without an intermediate formvar layer. (auth) (Canada)

Metabolism, Physiology, and Toxicology

Refer also to abstracts 11459, 11770, 11772, 12031, 12077, 12175, 12186, and 12229.

11901 (AEC-tr-7128, pp 39-49) THE CONCENTRATION FACTORS OF ^{90}Sr IN LIVING AND KILLED MARINE PLANTS. Baranova-Ryndina, D. D.; Polikarpov, G. G. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). Translated from report A-AC-82/G/L-1243.

An abstract of this paper from the original language has appeared previously in NSA as abstract number 24499. (H.L.W.)

11902 (AEC-tr-7128, pp 127-42) MECHANISM OF RADIOSTRONTIUM INTAKE IN POTATO TUBERS. Mel'nikova, M. K.; Baranova, Z. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). Translation of report A-AC-82/G/L-1288.

Increasing the temperature from 1 to 35°C caused no significant intensification of the process of absorption of ^{90}Sr by potato tubers. Data on temperature coefficients of the reaction of strontium absorption by the tubers demonstrated the nonmetabolic nature of the process. The diffusion nature of the process was indicated by the diffusion coefficients calculated for strontium and calcium in the tuber. Comparison of the data obtained under various experimental conditions with respect to temperature coefficients made it possible to conclude that the absorption of calcium and strontium by potato tubers is a physical process, diffusion, and is not metabolic in nature. (H.L.W.)

11903 (AEC-tr-7128, pp 246-53) METHOD OF CALCULATING THE CONTENT OF ^{90}Sr IN BONE TISSUE OF HUMAN ADULTS IN A PERIOD OF STRATOSPHERIC FALLOUT. Barkhudarov, R. M.; Stepanov, Yu. S. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). Translation of report A-AC-82/G/L-1303.

A method is proposed for theoretically estimating the concentration of ^{90}Sr in the bone tissue of human adults for any year following the injection of activity into the stratosphere. The variables (factors influencing the accumulation of ^{90}Sr in the skeleton) that are employed in the calculations include: the mean annual levels of ^{90}Sr fallout in areas of food production; coefficients of proportionality for ^{90}Sr transfer from fallout and soil into dietary intake; coefficients of discrimination for bone-dietary intake; and general constants characterizing the behavior of ^{90}Sr in the external environment. In comparisons with actual data for 1963 to 1967 for the population of the Soviet Union, the maximum divergence was 10%. (E.R.B.)

11904 (COO-1787-6) RELATIVE TRANSLOCATION AND DISTRIBUTION OF Pu AND Am FROM EXPERIMENTAL PuO_2 SUBCUTANEOUS IMPLANTS IN BEAGLES. Johnson, LaMar J. (Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology). Oct 1969. Contract AT(11-1)-1787. 212p. Dep. CFSTI.

Estimating plutonium burdens by in vivo measurement of the 59.5 keV ^{241}Am gamma ray has been a widespread practice in the nuclear industry. The assumption that plutonium and americium are identically metabolized within the biological system has been the basis for this procedure. A study of simulated puncture wounds in forty beagle dogs contaminated with PuO_2 provided data on the relative translocation and distribution of Pu and Am. Half of the dogs were given chelation therapy with the trisodium calcium salt of diethylene triaminepentaacetic acid (DTPA). The first major lymph node draining the implant site collected a significant fraction of the implanted material. The kinetics of the lymph node activity accumulation were studied by in vivo measurement. Empirical equations describing the activity buildup were derived. About 10% of the node burden was accumulated in the first two days. Pu/Am activity ratios served as indices of the relative concentration or retention within each type of sample. The experimental animals were serially sacrificed for tissue sample collection and radiochemical assay. Relative enhancement of Am concentration was shown in the reticuloendothelial tissues, the major Pu and Am concentrating soft tissues. Relative enhancement of Pu concentration was general in skeletal tissue. The magnitude of the enhancement increased with the blood cell forming activity of the bone. The disintegrations per minute per gram in the thyroid gland were low, but the relative Am enhancement was the largest of all the tissues. Administration of DTPA increased the relative Pu/Am ratio in urine, femur, and liver tissue. These samples from DTPA-treated dogs showed increases of 2, 3, and 5 fold, respectively, in the Pu/Am activity ratio. The data showed differential translocation and excretion of Pu and Am. Consideration of the relative metabolism of these elements in interpreting in vivo estimations of Pu burdens via Am measurement is needed. (auth)

11905 (EUR-4281) MOVEMENT OF CERTAIN ISOTOPES IN ANIMALS AND IN MAN. Annual Report, 1967. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Dec. 9, 1968. 55p. (In French). Dep. CFSTI (U. S. Sales Only).

The research conducted in 1967 proceeded successfully with some studies of the previous years such as the biology and the influence of the valency of rare earths and transuranic elements. Work on the removal of cesium by Prussian blue showed the different efficiencies of several blues. Owing to the progress achieved in information processing it was possible to show up the deviations between lung clearances with two different animal species, i.e., cats and rats, and two contamination processes widely different. The alveolar macrophage and the part it plays in the lung clearing process were studied systematically. (auth) (Euratom)

11906 (LFEN-NI-39-a) ACCUMULATION AND RETENTION OF ^{137}Cs BY CARASSIUS AURATUS L. Carolina Vaz Carreiro, Maria (Junta de Energia Nucleare, Sacavem (Portugal). Laboratorio de Fisica e Engenharia Nucleares). 1969. 14p. (In Portuguese). Dep. CFSTI (U. S. Sales Only).

The metabolism of ^{137}Cs in the fish, Carassius auratus, was studied in laboratory experiments. Cesium-137 was added to the water in the aquarium. Data on the uptake and retention of ^{137}Cs in muscle tissues at various times are reported. (C.H.)

11907 (LFEN-NI-40-a) ABSORPTION OF ^{137}Cs BY SPONDYLIOSOMA CANTHARUS L. Carolina Vaz Carreiro, Maria (Junta de Energia Nuclear, Sacavem (Portugal). Laboratorio de Fisica e Engenharia Nucleares). 1969. 14p. (In Portuguese). Dep. CFSTI (U. S. Sales Only).

The metabolism of ^{137}Cs in the fish, Spondyliosoma cantharus, was studied in laboratory experiments. Cesium-137 was added to the water in the aquarium and the fish were sacrificed seven days later. Bone and soft tissue samples were counted for ^{137}Cs activity using a scintillation detector. The tissues were also analyzed for Na content. Results indicated that ^{137}Cs was concentrated in muscle tissues. The relaxation of the findings to transport of ^{137}Cs through marine food chains to man is discussed. (C.H.)

11908 (ORO-672, pp 21-2) PLACENTAL TRANSFER AND FETAL DEVELOPMENT. Wykoff, M. H. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

A study was conducted on pregnant ewes to determine the immediate (within 1 hr) transfer of ^{134}Cs across the placental interface at 140 to 145 days gestation. The ^{134}Cs was not found to cross the placental interface within the first hour from either the maternal or fetal side. Similar studies with ^{85}Sr and ^{45}Ca indicated that these two isotopes passed readily from mother to fetus, but the reverse movement was slow, if existent. Studies with rats indicated that ^{85}Sr concentrated in the fetus only after ossification had begun. (C.O.)

11909 (ORO-672, pp 82-6) SWINE, SHEEP, AND BEEF CATTLE PHASE. Bell, M. C. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

The toxicity and metabolism of fission products and chemically

related nuclides among animal species (beef cattle, sheep, and swine) and the effects of irradiation on the metabolism of mineral elements were studied. Emphasis was placed on the nutrition of the whole animal function as a coordinated unit in contrast to the molecular biological approach. Results are summarized and data are presented in graphic and tabular form. (C.O.)

11910 (ORO-672, pp 93-6) MINERAL METABOLISM IN CATTLE. USE OF RADIOCERIUM FOR EVALUATING METHODS OF PLACING A DOSE DIRECTLY INTO THE BOVINE ABOMASUM. Miller, J. K. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

Cerium-144 and ^{141}Ce were administered to the abomasum of cattle using surgery, gelatin capsules, syringe after $CuSO_4$ swab, milk by nursing from nipple pails, and by capsule before nursing to young cattle; the effects of the dosing method on retention time and excretion were determined. Passage rates of abomasal milk doses were spread over longer periods, most likely by physical trapping of the marker in milk curd formed in the gastric stomach; therefore, suspension in H_2O appeared to be the method of choice for introducing a material directly into the abomasum. Data are presented in graphic and tabular form. (C.O.)

11911 (ORO-672, pp 100-4) METABOLISM OF FISSION PRODUCTS AND RELATED NUCLIDES IN POULTRY. Mraz, F. R. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

Chickens exhibited some effects of dietary levels of Ca and Sr even after a 20-hr fasting period. After a week or more, no appreciable effect of the previous diet appeared in relation to uptake of ^{45}Ca and ^{85}Sr. Mitochondria in mature pullets appeared to be influenced by ^{85}Sr added to the diet. While initially the ratio of ^{45}Ca to ^{85}Sr is 2:1 in the tibia at time of perfusion, discrimination against ^{85}Sr occurred so that 24 hr later it was 3:1. The perfusion of blood through the normal circulatory system of the shell gland to study ^{45}Ca transport was not found feasible. (C.O.)

11912 DEPENDENCE OF THE COEFFICIENTS OF ACCUMULATION OF ^{90}Sr IN HYDROBIONTS ON THE ASH CONTENT. Kulebakina, L. G. (Inst. of Biology of the Southern Seas, Sevastopol). Radiobiologiya; 9: 776-7(1969). (In Russian).

On the basis of materials obtained for 27 species of algae, molluscs, crustaceans, and fishes of the Black Sea it was found that there is a direct relationship between the coefficients of accumulation of strontium-90 and the ash content, which was described mathematically. (tr-auth)

11913 ARTIFICIAL RADIOACTIVITY OF GRAY WHALES. Sokolova, N. V. (Inst. of Fishing Industry and Oceanography, Magadan, USSR. Inst. of Biology of the Southern Seas, Sevastopol). Radiobiologiya; 9: 748-50(1969). (In Russian).

As a result of investigations conducted in 1966, the presence of artificial long-lived radioisotopes, strontium-90 and cesium-137, was detected in the tissues of gray whales. The radiostrontium content in the bones of gray whales was 13.7-43.4 pCi/kg, average concentration 20.95 ± 4.05 pCi/kg of crude weight. In the muscles, liver, skin, and contents of the stomachs of the whales, the radiocesium concentration varied from 39.1 to 125.4 pCi/kg of crude weight. (tr-auth)

11914 RELATIONSHIP BETWEEN ^{85}Sr UPTAKE AND HISTOLOGICAL CHANGES DURING HEALING IN DENTAL EXTRACTION WOUNDS IN RATS. Green, L. J.; Gong, J. K.; Neiders, M. E. (State Univ. of New York, Buffalo). Arch. Oral Biol.; 14: 865-72(Aug 1969).

Sprague-Dawley female rats (100 days of age) were utilized to study ^{85}Sr uptake and histological aspects of healing in dental extraction wounds of rats at varying intervals from 0 to 42 days following extraction of the maxillary left third molar. Fifty rats were injected intraperitoneally with 5 μCi of $^{85}SrCl_2$ 24 hr prior to sacrifice, while 10 uninjected animals were used for histological study. Radioactivity of bone from the right and left maxillary third molar areas was measured in a well-type scintillation detector with a NaI(Tl) crystal and expressed as either percentage of injected dose (% ID) or cpm/unit of fresh weight to the nearest 0.1 mg. The ratio of ^{85}Sr uptake was expressed as extracted site counts divided by nonextracted counts. When the ratio was less than 1.00, the histologic sections showed evidence of bone absorption and slight new bone formation whereas when the ratio was greater than unity, histologic sections showed marked evidence of predominant new bone formation. Significant differences were found between the uptake of ^{85}Sr (% ID/mg) in extraction and nonextraction sites during the period of 0 to 42 days. The differences in ^{85}Sr uptake at the 10th and 14th day corresponded with the times of greatest histologic activity of new bone formation in the healing sockets and extra-alveolar sites. (BBB)

11915 LOCALIZATION OF ^{58}Co AND ^{65}Zn-HEMATOPORPHYRIN COMPLEXES IN CANINE LYMPH NODES. Fawwaz, R. A.; Winchell, F. Frye; Hemphill, W.; Lawrence, J. H. (Univ. of California, Berkeley). J. Nucl. Med.; 10: 581-5(Sep 1969).

After the intravenous administration of ^{58}Co-hematoporphyrin to a series of dogs, the lymph nodes, kidneys, and liver showed the highest uptake of radioactivity. Radiosensitive tissues such as the duodenal mucosa and the bone marrow showed much less concentration of radioactivity. These findings, coupled with the marked vulnerability of the lymph cells to irradiation, raise the possibility of selective lymph node irradiation using appropriate radioisotopic metallo-hematoporphyrins. (auth)

11916 MALIGNANT TUMORS ASSOCIATED WITH SUBCUTANEOUSLY IMPLANTED ^{60}Co RADIOACTIVE WIRES IN PEROMYSCUS MANICULATUS. Cosgrove, G. E.; Dunaway, P. B.; Story, J. D. (Oak Ridge National Lab., Tenn.). Wildlife Dis. Ass., Bull.; 5: 311-14(Jul 1969).

Three adult deer mice were implanted in the dorsal interscapular region with ^{60}Co wire. The implantation was intended to demonstrate tracking techniques for studying range and activity patterns. Ten months later a subcutaneous tumor developed at the site of the implanted wire in one mouse, and a tumor developed in another mouse 20 months later. The third mouse died 15 months after implantation, but no tumor was present. The mice with tumors were killed and necropsies were performed. Photographs and descriptions of histological characteristics of tumors are presented. (H.L.W.)

11917 STUDIES ON THE METABOLISM OF ^{75}Se-L-SELENOCYSTINE AND ^{75}Se-DLmeso-SELENOCYSTINE WITH PARTICULAR REFERENCE TO THEIR USE AS PANCREATIC SCANNING AGENTS. Melmed, R. N.; Agnew, J. E.; Bouchier, I. A. D. (Royal Free Hospital, London). J. Nucl. Med.; 10: 575-80(Sep 1969).

Neither ^{75}Se-L- nor ^{75}Se-DLmeso-selenocystine are likely to replace ^{75}Se-L-selenomethionine as the agent of choice for pancreatic scanning. Although selenocystine has a shorter half-life in the body, the constant problem of renal overlap is likely to discourage its use. From whole-body retention studies and abdominal scans in rabbits it appears that tissue use of the natural L-configuration of selenocystine is greater than that of the DLmeso form. Because of the larger fraction of injected DLmeso-selenocystine lost in the urine, it is likely that renal tubular transport is also influenced by the configuration of the compound. Selenocystine injected by a peripheral vein behaves in a similar way to cystine in that a relatively large proportion of the dose is rapidly cleared and excreted by the kidney in rabbits and in man. (auth)

11918 ALTITUDE EFFECT ON THE BIOLOGICAL HALF LIFE OF CAESIUM IN MAN. Rundo, J. (Atomic Energy Research Establishment, Harwell, Eng.); Richmond, C. R. Nature (London); 225: 83-4(3 Jan 1970).

In humans at high altitudes there is a marked reduction in the rate of urinary excretion of aldosterone, with a slow return to normal. These changes account for the parallel decrease and increase in rates of salivary and urinary excretion of K and Na, respectively. A difference of about a factor of three in the ratio of salivary Na to K was observed for an altitude as low as 2,400 to 3,000 m compared with sea level values. A similar change in the rate of Cs excretion might be expected and such an effect was observed in a volunteer on an exchange visit from Harwell (100 m) to Los Alamos (2,200 m). Cesium 134 was used for the tests. (UK)

11919 THE RELATIONSHIP BETWEEN NITROGEN FIXATION AND THE PRODUCTION OF HD FROM D_2 BY CELL-FREE EXTRACTS OF SOYA-BEAN NODULE BACTEROIDS. Turner, G. L.; Bergersen, F. J. (Commonwealth Scientific and Industrial Research Organization, Canberra, Australia). Biochem. J.; 115: 529-35(Nov 1969).

Cell-free extracts prepared from soya-bean nodule bacteroids produced HD from D_2 in the presence of dithionite, an ATP-generating system and nitrogen. Crude extracts of bacteroids or of Azotobacter vinelandii showed some background D_2 exchange when any one of these compounds was omitted. Partial purification of bacteroid extracts diminished this background activity and gave increased D_2 exchange and nitrogen fixation. Although increasing pN_2 stimulated both reactions, the apparent K_m (N_2) for nitrogen fixation was much higher than the apparent K_m (N_2) for D_2 exchange when partially purified bacteroid extracts were used. Carbon monoxide was a competitive inhibitor of nitrogen fixation by partially purified bacteroid extracts, but D_2 exchange was inhibited in a noncompetitive fashion. These results are discussed in relation to the possible existence of enzyme-bound intermediates of nitrogen fixation. (auth) (UK)

11920 PANCREATIC CONCENTRATION OF ^{125}I-LABELED PHENYLALANINE IN MICE. Varma, Vijay M.; Beierwaltes, William H.; Lieberman, Lionel M.; Counsell, Raymond E. (Univ. of Michigan, Ann Arbor). J. Nucl. Med.; 10: 219-23(May 1969).

Experiments on mice showed specific pancreas localization of ^{125}I-labeled phenylalanine in approximately the same concentrations as the pancreatic concentration of ^{75}Se or ^{14}C-labeled DL phenylalanine. The pancreas concentration of ^{125}I after administration of iodinated amino acids was 5 to 9 times that in the liver 4 hr after administration. The specific concentration in the pancreas indicated that deleterious deiodination did not occur in the mouse during the 2 to 4 hr interval after administration. Specific concentration of ^{125}I in the malignant melanoma under these circumstances was thought to be related to the fact that phenylalanine is a precursor in melanin biosynthesis. The possibility of using the radioiodinated amino acids for scintillation scanning at 2 to 4 hr after administration for diagnosis of pancreatic lesions in man is discussed. Advantages of this method in comparison to the ^{75}Se-selenomethionine method are presented. (C.O.)

11921 PATHOPHYSIOLOGY OF FASCIOLA HEPATICA INFACTIONS. MacLean, J.; Holmes, P. H.; Dargie, J. D.; Mulligan, W. (Univ. of Glasgow). pp 117-23 of Isotopes and Radiation in Parasitology. Vienna; International Atomic Energy Agency (1968).

From Meeting on the Use of Isotopes and Radiation in Study and Control of Parasitic Diseases, Vienna, Austria. See STI/PUB-181; CONF-670738.

Anemia and hypoproteinemia are common features of fascioliasis. Experiments with ^{131}I-labeled albumin in rabbits and sheep have demonstrated an increased catabolic rate for albumin in animals infected with F. hepatica. That this is largely due to abnormal loss of plasma protein into the gastrointestinal tract, presumably via the bile, has been shown by measurements of fecal excretion of labeled polyvinylpyrrolidone. Studies on the anemia using ^{51}Cr-labeled red cells have demonstrated a shortened half-life of red cells in fluke-infected rabbits and sheep and a dramatic increase in the fecal radioactivity of the same animals. Again the picture is consistent with loss of red cells into the gut via flukes and bile. Simultaneous measurements of plasma protein loss and red cell loss into the gastrointestinal tract in infected animals have been carried out using albumin labeled with ^{95}Nb and red cells labeled with ^{51}Cr. The plasma protein loss into the gut is greater than can be accounted for in terms of blood. It would appear, therefore, that there is a loss of plasma protein over and above that involved in the whole blood loss. The histological picture in the bile ducts in infected animals is consistent with this finding. In the past interference with haemopoiesis and with plasma protein synthesis has been implicated in the anemia and hypoproteinemia. In the experiments described in this paper there was no evidence of reduced formation of either red cells or plasma protein; indeed the infected animals were producing red cells and protein at rates greatly in excess of those present in the controls. (auth)

11922 USE OF LABELLED REFERENCE SUBSTANCES IN STUDIES ON INTESTINAL ABSORPTION AND DIGESTIBILITY. Hurwitz, S. (Volcani Inst. of Agricultural Research, Rehovoth, Israel). pp 141-6 of Isotopes and Radiation in Parasitology. Vienna; International Atomic Energy Agency (1968).

From Meeting on the Use of Isotopes and Radiation in Study and Control of Parasitic Diseases, Vienna, Austria. See STI/PUB-181; CONF-670738.

There are several advantages in the use of reference substances over the classical balance technique, for studying the in vivo absorption of nutrients. Errors due to inaccuracies in estimation of feed intake and incomplete recovery of faeces are eliminated. Reference substances also permit the evaluation of short-term changes in absorption as well as the determination of the intestinal sites of absorption. A good reference substance should not be absorbed, should not modify the nutritional quality of the diet, and should be easily assayed. Most important, when absorption along the intestine is studied, the rate of passage of the reference substance along the intestine should be comparable to that of the nutrient under study. Labeled reference substances are preferable to nonlabeled ones, as long as suitable facilities are available. This technique was found useful in the evaluation of calcium absorption in laying hens as a function of dietary calcium level and various physiological states. It is suggested that this technique may be used to evaluate the degree of functional intestinal damage by parasitic infection, as well as the time course in the development of the disorder. Reference substances may also be used for accurate evaluation of changes in the rate of passage of nutrients through the digestive tract. (auth)

11923 MICROSCOPIC DISTRIBUTION OF ^{241}Am IN THE BEAGLE THYROID GLAND. Taylor, G. N.; Jee, W. S. S.; Dockum, N.; Hromyk, E. (Univ. of Utah, Salt Lake City). Health Phys.; 17: 723-5(Nov 1969).

Relatively high retention of ^{241}Am in the skeleton and liver of some species is well known. More recently canine studies have demonstrated an additional site of relatively high deposition, the thyroid, where the concentration exceeded that of the skeleton during post injection intervals, extending up to 448 days—the longest time studied thus far. ^{241}Am deposition in the beagle thyroid gland occurred principally in the interfollicular areas. Lesser amounts were also retained in the tunica media and/or intima of some of the arterioles. Retention in the follicular epithelium, the colloid, and the collagenous structures, such as the capsule and interlobular septa, was low. There was no significant change in this general distribution pattern over a period of 448 days. (UK)

11924 AN ANALYSIS OF THE WHOLE-BODY RETENTION OF ^{137}Cs IN RATS OF VARIOUS AGES. Stather, John W. (Radiological Protection Service, Belmont, Eng.). Health Phys.; 18: 43-52(Jan 1970).

The whole-body retention kinetics of ^{137}Cs in rats of various ages are explained by an analysis of tissues, urine and feces. For rats up to 8 weeks of age the retention kinetics for the first 2 weeks following intraperitoneal injection of ^{137}Cs can be expressed by a one component exponential function, and for older animals by a two component function. One week old rats have a very slow rate of loss of ^{137}Cs which is probably due to incompletely developed kidney function. In older animals, the rate of loss of ^{137}Cs increases with age, reaching a maximum at about 4 weeks of age, and then decreasing again. Where there is a two component system, the initial fast component is mainly due to the excretion in the urine of a large proportion of the ^{137}Cs picked up by the kidney in the first few minutes after injection. The increase in the half-time of the long term component after 4 weeks of age can be accounted for by a declining turnover rate of ^{137}Cs in the muscle tissue of older animals. (auth) (UK)

11925 MAINTENANCE OF PHAGOCYTIC FUNCTION FOLLOWING $^{239}PuO_2$ PARTICLE ADMINISTRATION. Sanders, Charles L. (Battelle-Northwest, Richland, Wash.). Health Phys.; 18: 82-5(Jan 1970).

Phagocytic function of peritoneal phagocytes was tested following injection of plutonium particles, using latex beads as a test particulate. Overall, there was no depression in phagocytic function following deposition of up to 19 μCi $^{239}PuO_2$ particles in the peritoneal cavity. The phagocytosis of latex beads was reduced only in those individual macrophages which had previously engulfed a large mass of plutonium particles. (auth) (UK)

11926 EFFECT OF STABLE YTTRIUM CONCENTRATION ON THE DISTRIBUTION AND EXCRETION OF INHALED RADIO-YTTRIUM IN THE RAT. Wenzel, W. J.; Thomas, R. G.; McClellan, R. O. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Contract AT(29-2)-1013. Amer. Ind. Hyg. Ass. J.; 30: 630-4(Nov-Dec 1969).

Groups of rats were exposed by inhalation to aerosols containing ^{88}Y, either carrier-free or with stable ^{89}Y added in graded amounts, to determine what effect the added carrier has on retention patterns of the tracer. In all rats, the highest concentrations of ^{88}Y were noted in skeleton, lung, and liver. At 32 days postexposure the rats exposed to the highest concentration of carrier (^{89}Y/^{88}Y = 2.18×10^5) had 30% more of the whole-body ^{88}Y in lung and 28% less in skeleton. Data from groups receiving intermediate amounts of carrier indicate proportionate shifts in tissue distribution. Fecal excretion of ^{88}Y was greatest for rats exposed to carrier Y-containing particles. (auth)

11927 CONTAMINATION WITH ^{203}Hg in RAT NEONATES FED WITH THE MILK OF MOTHERS IN WHICH NEOHYDRINE LABELED WITH ^{203}Hg WAS INJECTED INTRAVENOUSLY. Baltrukiewicz, Zenon. Acta Physiol. Pol.; 20: 805-11(Sep-Oct 1969). (In Polish).

In post-partum female rats, 0.2 ml of neohydrin solution labeled with ^{203}Hg with activity of about 4 μCi per animal was injected in different stages of breast feeding. Twenty-four hours after the injections, contamination of the young rats was measured by means of a special setup making possible measurement of the activity of the whole body. Transmission of ^{203}Hg to the breast-fed neonates showed a stepped character; the content of ^{203}Hg in the bodies of the young rats increased after the isotope was injected in the mothers, and then decreased gradually. The percentage of ^{203}Hg in the milk increased with lapse of time. Single injections of ^{203}Hg neohydrin in the females during pregnancy caused no contamination of the neonates. Neohydrin-^{203}Hg injected intravenously during

lactation caused internal contamination of the breast-fed rats equivalent to a percentage of the injected dose and several tens of times the value of the natural background. (auth)

Radiation Effects

Refer also to abstracts 12044, 12045, 12053, 12106, 12120, 12133, 12212, 12226, 12242, 12305, and 12345.

11928 (IA–1190, pp 235-56) HEALTH PHYSICS AND BIOLOGY. (Israel Atomic Energy Commission, Tel Aviv).

Health Physics activities include provision of a personnel monitoring service for workers throughout the country who are exposed to ionizing radiation; supervision of the health physics aspects of the Israel AEC Laboratories; environmental monitoring, including evaluation of radioactive fallout, assessment of radioactivity in food samples, bioassay of radiation workers, and off-site monitoring; and radiation dosimetry and development of instrumentation. Individual studies are reported on measurement of long-lived fission products in food; environmental monitoring of radioiodine in animal thyroids; uptake and metabolism of radionuclides by aquatic vascular plants as compared with alfalfa; calculation of dose rate distribution of ^{125}I in the thyroid follicle; effects of stable elements in the environment on the maximum permissible concentration of radionuclides; skin beta dose factors; estimation of beta fields from known gamma fields; effect of physical activity on the cesium and potassium levels in humans as determined by whole body counting; transfer of ^{144}Ce via placenta and during lactation to offspring in mice; and photoproducts of uv-irradiated frozen thymine solutions and of DNA. (H.L.W.)

11929 (NYO–3467-2) RADIATION DAMAGE TO THE ELECTROCHEMICAL AND BIOCHEMICAL ACTIVITIES OF MUSCLE MEMBRANE. Final Progress Report, April 1, 1968–May 31, 1969. Perez, Carlos (Buenos Aires Univ. (Argentina). Facultad de Medicina). Contract AT(30-1)-3467. 94p. Dep. CFSTI.

It is the purpose of this research program to identify and characterize in cellular and subcellular membrane structures, the critical membrane systems, organelles and biochemical mechanisms which are affected by the absorption of ionizing radiation; the chain of aberrant physicochemical events which follows, eventually resulting in observable changes in cellular performance. This research work is divided into two major approaches for studying the effects of radiation on membrane organization and functions: biophysical properties of the electrical and chemical excitable membranes and biochemical studies of the organized membranes, including the cell membrane, mitochondrial and microsomal membranes. In experimental animals with distinct differences in radiosensitivity, (rats and frogs) it is possible to ascertain some of the elements involved in biological responses to ionizing radiation. The goal of this research can be indicated by the work in progress during the recent years: membrane systems and control mechanisms; maintenance of membrane systems; the vectorial character of membrane systems; the permeability of membrane systems; membranes and metabolic sequences; and modification of the form of complexes by action of enzymes, activators, inhibitors, blocking agents and radiation. (auth)

11930 (ORO–2832-79, pp 13-41) IRRADIATION STUDIES OF RECONSTITUTED NUCLEOHISTONES. Ansevin, Allen T.; Kennedy, Vicki; Kehm, Susan (Anderson (M. D.) Hospital and Tumor Inst., Houston, Tex.).

Equipment and techniques used in preparative electrophoresis of histone fractions are discussed and described. Parameter scanning programs (PARSCAN and DIMPS) that are capable of performing bias-free fits (i.e., without the initial input of monomer molecular weight) of observed data to various models of monomer–polymer distributions are also discussed. The equipment used in the nucleoprotein reconstitution experiments is described and conditions under which reconstitution (F2b histone with calf thymus DNA) took place are discussed; data are presented in graphic form. The experimental design used in the study of ^{137}Cs γ irradiation of reconstituted nucleoproteins is outlined. Results of studies on nucleoproteins containing F1 histone and calf thymus DNA are presented and corresponding experiments with F3 histone and with moderately lysine-rich fraction F2b (containing histidine but not cysteine) followed. Data are presented in graphic form. In general, double and single strand breaks were greatly reduced by F1 reconstitution; 2M salt also gave a significant protection from double strand breaks. (C.O.)

11931 (ORO–2832-79, pp 42-4) DIRECT AND INDIRECT RADIATION EFFECTS IN E. COLI RELATED TO VIABILITY AND DNA STRAND BREAKAGE. Shalek, Robert J.; Smith, Charles E. (Anderson (M. D.) Hospital and Tumor Inst., Houston, Tex.).

The procedure used to label the DNA of Escherichia coli with ^{3}H-thymidine is outlined. For an experiment, samples are raised rapidly from liquid N_2 temperature to the desired irradiation temperature. Duplicate samples were irradiated and DNA sedimentation analyses were carried out and cell survival was determined. The only data presented consisted of a sedimentation profile of native and alkali denatured DNA from E. coli B3 cells with ^{3}H-thymidine; three simultaneous runs of each type were plotted. (C.O.)

11932 CONTENT OF REDUCED PYRIDINE NUCLEOTIDES IN THE LIVER MITOCHONDRIA OF IRRADIATED RATS. Smirnova, T. N.; Svishchev, G. M.; Romantsev, E. F. (Inst. of Biophysics, Moscow). Radiobiologiya; 9: 751-4(1969). (In Russian).

The concentration of reduced pyridine nucleotides in the liver mitochondria of rats irradiated with 1000 R of γ-rays was investigated. A decrease in the concentration of NADP'H in the liver mitochondria was detected 3 and 24 hrs after irradiation. No change in the NAD'H concentration was detected during the indicated periods. (tr-auth)

11933 UV INDUCTION OF THE SYNTHESIS OF E1 COLICIN AND THE REPAIR OF UV DAMAGES IN E. COLI. Likhoded, V. G.; Padalko, T. B.; Saenko, A. S. (Inst. of Vaccines and Sera, Moscow. Inst. of Medical Radiology, Obninsk, USSR). Radiobiologiya; 9: 733-6(1969). (In Russian).

The system of dark repair in E. coli repairs the uv damages that induce colicin synthesis. Induction in the strain hcr^{+} required substantially larger doses of uv-irradiation than induction in the strain hcr^{-} with impaired ability for dark repair. Acridine orange, which suppresses dark repair, lowers the dose of uv light required for induction of the strain hcr^{+} to the level of the doses that induce hcr^{-} cells. (tr-auth)

11934 RADIOCHEMICAL DISTURBANCE OF ATP SYNTHESIS IN THE NUCLEI OF THYMUS CELLS. Kuzin, A. M.; Tarshis, M. A. (Inst. of Biological Physics, Pushchino-on-Oka, USSR). Radiobiologiya; 9: 755-7(1969). (In Russian).

The ability of isolated thymus cell nuclei to synthesize ATP under aerobic conditions (0.272 ± 0.008 μmole) from intranuclear precursors was demonstrated with the aid of an enzymatic method; the independence of this synthesis from mitochondrial impurities was also demonstrated. After 30 min, ionizing radiation reduces nuclear synthesis of ATP by 31.9%; the disturbance increases with time and reaches 90.81% by 2 hrs. Irradiation of isolated nuclei produces a more profound disturbance of ATP synthesis. (tr-auth)

11935 IN VITRO EFFECTS OF STEROIDS AND RADIATION ON THE INCORPORATION OF ^{14}C–THYMIDINE, ^{14}C–URIDINE, AND ^{14}C–LEUCINE INTO EHRLICH ASCITES TUMOR CELLS OF MICE. Hoffmann, Klaus; Anger, Klaus; Hirschmann, Wolf-Dietrich; Feine, Ulrich (Univ., Tuebingen, Ger.). Strahlentherapie; 138: 471-80(Oct 1969). (In German).

The effects of synthetic corticoids, of irradiation, or a combination of both were studied on the incorporation in vitro of ^{14}C-thymidine, of ^{14}C-uridine and of ^{14}C-leucine with Ehrlich ascites tumor cells. The corticoids decrease mostly the uridine-incorporation, whereas the irradiation decreases the thymidine incorporation. When both are associated, an additive effect on the thymidine incorporation occurs with water-soluble corticosteroids; with water-insoluble steroids, however, there is an inhibition of the radiation effect. The incorporation of uridine and leucine corresponds to the effect of the steroids when in association or not. There is a marked influence of the culture medium. This effect and the mode of action of both agents are discussed. (auth)

11936 FACTORS DETERMINING THE CHANGE IN THE SECONDARY STRUCTURE OF DNA UNDER THE ACTION OF IONIZING RADIATION. Simonov, V. V.; Ryabchenko, N. I.; Poverennyi, A. M. (Inst. of Medical Radiology, Obninsk). Radiobiologiya; 9: 663-7(1969). (In Russian).

The state of the secondary structure of DNA subjected to the action of x rays was studied by the methods of melting at suboptimal temperature in the presence of formaldehyde and differential spectrophotometry. The presence of changes in the secondary structure of the DNA molecule under the influence of comparatively low doses of ionizing radiation was demonstrated. Denaturation changes arise to a greater degree in portions enriched with AT pairs. (tr-auth)

11937 INVESTIGATION OF THE RELATIONSHIP OF PARAMAGNETIC CENTERS AND THE RADIATION DAMAGES FORMED DURING GAMMA-IRRADIATION OF DRY PREPARATIONS OF DNA. Milinchuk, V. K.; Ryabchenko, N. I.; Pshezhetskii, S. Ya.; Tseitlin, P. I. (Physical-Chemistry Scientific

Research Inst., Irkutsh, USSR). Radiobiologiya; 9: 659-62 (1969). (In Russian).

It was established by the EPR method that illumination of γ-irradiated preparations of DNA at 77°K lowers the concentration of paramagnetic centers by ~80%. The solubility of DNA samples increases by ~40% after irradiation by visible light in comparison with nonilluminated preparations. The number of cleavages in the nonilluminated and illuminated samples of DNA coincides. There is a quantitative correlation between the number of cleavages and the concentration of free radicals stable at room temperature. (tr-auth)

11938 EFFECTS OF HIGH DOSES OF THE GAMMA-RADIATION OF ^{60}Co ON THE CHEMICAL STRUCTURE OF MYOSIN. Sukhomlinov, B. F.; Oleinik, Ya. V. (Lvov State Univ.). Radiobiologiya; 9: 671-4(1969). (In Russian).

The results of experimental studies of the peptide composition of tryptic hydrolyzates of myosin, isolated from intact beef and beef irradiated with $1-5 \times 10^6$ Rad of γ-rays of ^{60}Co are cited. It was established that with increasing dose of irradiation of the meat, the amount of high-molecular peptides in the tryptic hydrolyzates of myosin decreases, and the number of low-molecular peptide fragments increases, i.e., irradiation of meat with high doses of γ-radiation promotes more profound trypsin hydrolysis of myosin. (tr-auth)

11939 CHANGES IN THE NUCLEOTIDE COMPOSITION OF DNA OF MOUSE AND MONKEY HEMATOGENIC TISSUE AFTER TOTAL IRRADIATION WITH GAMMA-RAYS AT DOSES WITH THE MOST EFFECTIVE LEUKEMOGENIC EFFECT. Grigorovich, N. A. (Scientific Research Inst. of Oncology and Medical Radiology, Minsk). Radiobiologiya; 9: 682-5(1969). (In Russian).

The nucleotide composition of the DNA of mouse and monkey hematogenic tissue was studied by descending chromatography and high-voltage electrophoresis for a month after irradiation of the animals with 400 to 600 R of γ-rays, which exhibit the greatest leukemogenic effect. It was shown that the most sensitive to the action of radiation are guanine and thymine; moreover, the guanine content increased after irradiation, while the amount of thymine decreased. The changes in the nucleotide composition of the DNA of monkey hematogenic tissue were more pronounced than in the mouse DNA. (tr-auth)

11940 INFLUENCE OF IRRADIATION ON THE GLYCOLYSIS OF ISOLATED CALF THYMUS NUCLEI. Slozhenikina, L. V.; Migushina, V. L.; Kuzin, A. M. (Inst. of Biological Physics, Pushchino-on-Oka, USSR). Radiobiologiya; 9: 686-91(1969). (In Russian).

The stability of glycolysis in isolated calf thymus nuclei to the action of ionizing radiation was demonstrated. The anaerobic conversion of fructose-1,6-diphosphate was not disturbed 1, 2 and 3 hrs after irradiation of isolated thymocyte nuclei at a dose of 900 R. In the case of total irradiation of rats at the same dose, the glycolytic ability of the calf thymus nuclei was unchanged during the first 4 hrs after irradiation. The use of exogenous substrates of glycolysis by thymocyte nuclei was inhibited in the following hours after the action of ionizing radiation. The activity of the glycolytic enzymes (lactate dehydrogenase) was inhibited 15 hrs after irradiation. (tr-auth)

11941 PATHOGENESIS OF POSTRADIATION ANEMIA. Voronin, V. S. (Inst. of Biophysics, Moscow). Radiobiologiya; 9: 692-6(1969). (In Russian).

In work conducted on male rats of the Wistar line, irradiated at doses of 400, 600, and 800 R, the rate of formation and qualitative state of the erythrocytes were studied at various periods after a radiation influence. It was shown that the significance of these factors in lowering the number of erythrocytes is not equivalent at different periods after irradiation. A distinct dose dependence in the variation of the indexes studied was detected. (tr-auth)

11942 THE EXCRETION OF DEOXYCYTIDINE AND METHYL-DEOXYCYTIDINE IN URINE OF RATS FOLLOWING INCORPORATION OF ^{144}Ce. Solle, Margit; Gensicke, Friedrich (Staatliche Zentrale fuer Strahlenschutz, Berlin). Int. J. Radiat. Biol.; 15: 507-17(1969). (In German).

The effects of a single intravenous injection of radiocerium chloride (15 to 850 μCi ^{144}Ce/rat) on the excretion of deoxycytidine and methyldeoxycytidine by rat urine are given. After the injection of more than 30 μCi ^{144}Ce/rat, a temporary increase of the excretion of both metabolites, which is statistically significant, can be proved. The duration and degree of the increased excretion of deoxyribosides depend on the quantity of the injected radioactivity. The results are discussed in view of the possible use of the deoxyriboside values in urine as biological dosimeter. Dosimetric data and results of x irradiation are included. (auth)

11943 RELATIVE EFFECTS OF RADIATION ON DE NOVO DNA BASE SYNTHESIS AND THYMIDINE INCORPORATION INTO DNA. Winchell, H. S.; Vimokesant, S.; Raley, R. (Univ. of California, Berkeley). J. Nucl. Med.; 10: 624-27(Oct 1969).

The synthesis of DNA thymine and adenine using monocarbon units from ^{14}C-labeled formate or 3-^{14}C-labeled serine was found to be more radiosensitive than the incorporation of tritiated thymidine into DNA thymine. Since both the de novo synthesis of the pyrimidine, thymine, as well as the purine, adenine, were markedly suppressed after radiation, it was postulated that the common metabolic pathway requiring monocarbon transport needed in the synthesis of both these bases may be markedly radiosensitive. It is further postulated that this step is more radiosensitive than metabolic steps required for the incorporation of DNA bases into the DNA molecule. Results suggest that after irradiation the incorporation of tritiated thymidine into DNA is not a good measure of overall DNA synthesis but may rather be a measure of the incorporation of preformed thymidine, from reutilization pathways, into DNA. (auth)

11944 AUTORADIOGRAPHIC STUDIES ON THE MECHANISM OF RADIATION-INDUCED BRAIN MALFORMATION IN RATS. Wegner, Gert (Univ., Freiburg i. B.). Strahlentherapie; 138: 496-505(Oct 1969). (In German).

The DNA-synthesis and mitosis frequency in early embryonic rat brains was investigated autoradiographically after a single whole-body irradiation. Following factors cause radiation induced malformations: The acute cell death, a restraint of three partial phases of the embryonic cell generation that may continue until 24 hours, particularly the phases of DNA-synthesis and mitosis. The result is a continuing reduction of mitosis. After a short interval between 24 and 48 hours post x-irradiation, with a ^{3}H-index equal to the control, the number of DNA-synthetizing cells decreases again, and a cell death ensues. Particularly in the cerebral-formation the increase of severe cerebral deformities can be seen at this time. (auth)

11945 REACTION OF STIMULATED PLASMA-ALBUMIN SYNTHESIS TO PARTIAL LIVER IRRADIATION, AS DETECTED WITH TRITIATED LEUCINE. Staehler, Fritz (Univ., Hamburg). Strahlentherapie; 138: 449-56(Oct 1969). (In German).

The rate of synthesis of plasma proteins is greatly increased after the exchange of 75% of the plasma proteins for a colloidal substance. The incorporation of tritiated leucine in the plasma-albumin and in the soluble proteins of the cytoplasm of the liver cells of rats was followed during 48 hours after irradiation. A partial irradiation directed to the liver greatly disturbs the normal reactions. After 1000 rd there is a reversible inhibition of the biosynthesis of the proteins. After 5000 rd, however, there is an increase of the synthesis during a few hours before this inhibition period. (auth)

11946 EFFECTS OF IONIZING RADIATION ON THE ACTIVATION OF LYSINE AND THE AMINOACYLATION OF tRNA BY LYSYL-tRNA-SYNTHETASE FROM RAT LIVER. Hanson, K. P.; Orlova, T. A.; Shutko, A. N. (Central Roentgenoradiological Scientific Research Inst., Leningrad). Radiobiologiya; 9: 668-70(1969). (In Russian).

The kinetic principles of the activation of lysine and the transfer of the activated amino acid to tRNA under the action of x-irradiated (at a dose of 30 kR) lysyl-tRNA synthetase were studied. It was shown that irradiation does not produce any decrease in the enzyme activity, evaluated according to the rate of formation of the final product of the reaction (lysyl-tRNA). However, a mathematical analysis of the experimental data revealed substantial changes in the rates of the individual steps of the reaction studied in the case when it is catalyzed by the irradiated enzyme. (tr-auth)

11947 PYRIMIDINE NUCLEOTIDE BLOCKS OF DNA UNDER THE INFLUENCE OF IONIZING RADIATION ON THE ANIMAL ORGANISM. Kritskii, G. A.; Abidov, A. A.; Surina, T. Ya. (Inst. of Biochemistry, Moscow). Radiobiologiya; 9: 675-81(1969). (In Russian).

It was shown that immediately after local x-irradiation of animals at doses of 200 and 2000 R, a significant decrease in the relative content of pyrimidine nucleotide blocks and an increase in the content of a single thymidyl nucleotide residue in the DNA of fraction I of rabbit bone marrow in comparison with the norm are detected. The survival of irradiated mice treated with pyrimidine nucleotide blocks of DNA is significantly increased in comparison with the untreated control. (tr-auth)

11948 INVESTIGATION OF THE BIOELECTRIC ACTIVITY IN THE MESENTERIC NERVES OF THE CAT IN THE CASE OF WHOLE-BODY AND LOCAL X-IRRADIATION. Maiorova, N. F.

(Central Roentgenoradiological Scientific Research Inst., Leningrad). Radiobiologiya; 9: 764-6(1969). (In Russian).

It was shown that whole-body x-irradiation of cats at a dose of 550 R produces a change (in most cases an intensification) in the afferent and efferent activity in the mesenteric nerves of the cat within the first minutes after irradiation. Local irradiation of the abdomen at doses of 550 to 1000 R produces an intensification of the afferent impulsation, while irradiation at doses of 1800 to 2000 R produces an inhibition or total reduction of the biopotentials. (tr-auth)

11949 INFLUENCE OF LARGE DOSES OF RADIATION ON THE LIPID CONTENT IN THE CRYSTALLINE LENS OF THE GRASS FROG. Simakov, Yu. G.; Poluektova, L. M.; Popov, V. V. (Moscow State Univ.). Radiobiologiya; 9: 784-5(1969). (In Russian).

When the eyes of frogs Rana temporaria are irradiated at a dose of 10 kR, the crystalline lenses remain transparent for 35 days. Histochemical reactions and microspectrophotometry of slices revealed that the total lipid content in the crystalline lens is lowered after irradiation. The cortex, where the lipid content is higher than in the nucleus of the crystalline lens, is especially impoverished. Microphotometry indicated that the drop in the lipids begins two weeks after irradiation and ceases on the 22nd day. (tr-auth)

11950 SERUM GROWTH HORMONE LEVELS AND RESPONSE OF DIABETIC RETINOPATHY TO PITUITARY ABLATION. Wright, A. D.; Kohner, E. M.; Oakley, N. W.; Hartog, M.; Joplin, G. F.; Fraser, T. Russell (Royal Postgraduate Medical School, London). Brit. Med. J.; 2: 346-8(10 May 1969).

The effects of ^{90}Y implantation in the pituitary on serum growth hormone levels were studied during insulin tolerance tests in 36 patients treated for diabetic retinopathy. The implants were planned to give three dose levels specified at the gland surface; these were 50,000 rad in seven patients, 150,000 rad in 30, and 300,000 rad in three. Four patients were reimplanted 5 to 13 months after an initial implant had failed to induce hypopituitarism. The response of the new blood vessels was more clearly related to loss of growth hormone function than was the improvement of retinal hemorrhages and microaneurysms. The overall response of the retinopathy was greatest when growth hormone function was lost. Complete loss of growth hormone reserve, however, was not essential because the response when growth hormone reserve was maximally reduced was no better than the response in the other growth hormone grades. Since the loss of growth hormone function was related to the loss of other aspects of anterior pituitary function, a unique role of growth hormone in the response of diabetic retinopathy to pituitary ablation could not be established. (BBB)

11951 ROLE OF DNA DAMAGE AND ITS REPAIR IN THE INACTIVATION OF CELLS BY IONIZING RADIATIONS. Dean, C. J. (Chester Beatty Research Inst., Sutton, Eng.). pp 23-38 of Effects of Radiation on Cellular Proliferation and Differentiation. Vienna; International Atomic Energy Agency (1968).

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco. See STI/PUB-186; CONF-680413.

Current concepts in radiobiology implicate DNA as the site of the primary lesion that leads to the loss of a cell's capacity for indefinite proliferation, and it is thought that the efficiency with which a cell can repair this damage largely determines the radiosensitivity. Bacterial and mammalian cells have the capacity to repair part or all of the radiation damage to their DNA, but a precise evaluation of the processes involved is difficult, since little is known regarding the chemical nature of the radiation-induced lesions. The types of DNA lesion that have been recognized from studies with isolated DNA, bacteriophage, and cell systems are considered and the similarity in the repair of uv and ionizing radiation damage to DNA is discussed in the light of the data available. (auth)

11952 RADIATION-INDUCED DNA LABELLING IN G_1 PHASE IN HeLa-S_3 CELLS. Feinendegen, L. E. (Kernforschungsanlage, Juelich, Ger.); Drew, R. M.; Bond, V. P.; Heiniger, H. J. pp 39-55 of Effects of Radiation on Cellular Proliferation and Differentiation. Vienna; International Atomic Energy Agency (1968).

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco. See STI/PUB-186; CONF-680413.

The primary aim of the experiments was to examine in HeLa-S_3 tissue culture cells the effect of a single dose of x irradiation on the rate of entry of cells into synthesizing DNA. To determine the rate at which cells enter DNA synthesis, different tracer techniques may be used. In this study, autoradiography with ^3H-cytidine was chosen. ^3H-cytidine enters a relatively large cellular precursor pool and can be utilized from there for DNA synthesis for at least one generation time. Using this technique, one observes autoradiographically the rise in the relative number of DNA-labeled cells as a function of the proliferative rate with time after flash-exposure of the cells to ^3H-cytidine. Tracing the influx of DNA precursor from the cellular pool into DNA is physiological and eliminates the requirement of handling the cultures during experiment. Moreover, the effects on various phases of the cell cycle may be analyzed without having the cultures in a synchronous state of growth. After x irradiation with 500 and 1000 R, an immediate mitotic delay was observed, that recovered between 16 and 24 hr after irradiation. Approximately 10% of the cell population was induced into synthesizing DNA. The effect occurred within 2 hr after irradiation. This increase of the labeling index was not due to changes in the autoradiographic efficiency, as was observed from measurements by interference microscopy, but to nuclear thickness and total nuclear mass. Analysis of the labeling index curves indicated that mainly cells of the latter part of the G_1 phase were induced to synthesize DNA by irradiation. The rate of transition of G_1 cells into S-phase following the initial effect was near normal and indistinguishable from the control values, at least for 8 hr after irradiation. (auth)

11953 RADIATION-INDUCED CHANGES IN SOME BIOCHEMICAL PARAMETERS OF THE HAEMOPOIETIC TISSUE OF RABBITS. Izak, G.; Karsai, A.; Eylon, L. (Hadassah Univ. Hospital, Jerusalem. Hebrew Univ.-Hadassah Medical School, Jerusalem). pp 57-66 of Effects of Radiation on Cellular Proliferation and Differentiation. Vienna; International Atomic Energy Agency (1968).

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco. See STI/PUB-186; CONF-680413.

Bone-marrow and reticulocyte suspensions obtained from rabbits following massive hemorrhage were γ-irradiated by a ^{60}Co source with doses ranging between 1000 to 10,000 rad. The radioinduced injury to the nucleic acid synthesizing apparatus and to the heme- and protein-producing activity of the bone-marrow cells, as well as the damage to the hemoglobin synthesizing system of the reticulocytes, was investigated shortly after exposure. The amino-acid incorporation activity into protein was substantially reduced, together with all the other parameters measured in the bone-marrow cells, while globin synthesis was not affected at the same radiation dose in the reticulocytes. On the other hand, incorporation of heme precursors into protoporphyrin was inhibited both in the nucleated erythroid precursors and in the reticulocytes, more so in the former than in the latter. The implications of these findings and possible means to repair the biochemical injury are discussed. (auth)

11954 FACTORS INFLUENCING PREMATURE INDUCTION OF UDP-GLUCURONYLTRANSFERASE ACTIVITY IN CULTURED CHICK EMBRYO LIVER CELLS. Skea, Brian R.; Nemeth, Andrew M. (Univ. of Dundee, Scotland. Univ. of Pennsylvania, Philadelphia). Proc. Nat. Acad. Sci. U. S.; 64: 795-802(Oct 1969).

Very young (5-day-old) chick embryo livers during organ culture on rafts over a chemically defined nutrient medium precociously develop, from zero, adult levels of UDP-glucuronyltransferase activity. Induction of enzyme does not require DNA synthesis or mitosis, or exposure to hormones, serum, or tissue extracts. Thus, this functional differentiation of embryo liver is apparently not dependent on cell proliferation or on extrinsic substances other than simple nutrients. UDP-glucuronyltransferase activity develops rapidly also in embryo liver cells cultured as monolayers or aggregates; specific activity of enzyme on a protein basis increases at the same rate in cells undergoing widely different rates of cell division, and net protein synthesis. These findings suggest that precocious development of UDP-glucuronyltransferase activity in chick embryo liver is caused, not by incidents of culture, but by removal from the embryonic environment. Supporting this, chick embryo liver grafted to the chorioallantoic membrane does not develop UDP-glucuronyltransferase activity until subsequently transferred to an in vitro cell culture system. (auth)

11955 INSTABILITY IN ALKALINE MEDIA OF RADIOINDUCED OLIGODESOXYNUCLEOTIDES. Simon, M. (Kernforschungszentrum, Karlsluhe, Ger.). Int. J. Radiat. Biol.; 16: 167-82 (1969). (In French).

The oligonucleotides which are formed by γ-irradiation from polydeoxynucleotides have been studied. They were characterized by chromatographic and enzymatic methods according to their charge and their terminal groups. These oligonucleotides were not stable in alkaline solution; new phosphate groups were formed

which could be liberated by monophosphoesterase. Further, short oligonucleotides could be detected after alkaline incubation, probably due to β-elimination. In addition, cyclophosphates were formed as consequence of nucleotide base liberation. The mechanisms leading to the instability of radiation-induced oligonucleotides and the reactions involved in the strand scission of DNA were discussed. (auth) (UK)

11956 EFFECT OF X-RADIATION ON INCORPORATION OF LABELED AMINO ACIDS IN NUCLEAR AND CYTOPLASMIC PROTEINS OF RAT REGENERATING LIVERS. Van Lancker, J. L.; Ballard, Anne (Brown Univ., Providence). Exp. Hematol.; No. 19, 35-7(1969).

From Bone Marrow Conference, Atlantic City, N. J. See CONF-690434.

Earlier studies on regenerating rat livers demonstrated that x irradiation interferes with the incorporation of ^{14}C-lysine into nuclear protein, but has no effect on the incorporation of ^{14}C-leucine. Studies made of the effects of x irradiation on the incorporation of other ^{14}C-labeled amino acids are reported. The incorporation of threonine was inhibited 25.9% in the nuclear and 22.6% in the cytoplasmic fractions. Arginine was inhibited 31% in the nuclear and 28% in the cytoplasmic fractions. Glycine was inhibited 20% in the cytoplasmic fraction but not significantly in the nuclear fractions. Radiation did not significantly affect the incorporation of labeled tryptophan, tyrosine, isoleucine, glutamic acid, valine, or phenylalanine. (M.M.B.)

11957 STRUCTURAL AND FUNCTIONAL CHANGES IN DNA AFTER EXPOSURE TO HYDROGEN ATOMS AND GAMMA RADIATION. Jung, H.; Hagen, U.; Ullrich, M.; Pettersen, E. E. (Kernforschungszentrum, Karlsruhe, Ger.). Z. Naturforsch.; 24b: 1565-73(Dec 1969).

The action of hydrogen atoms (generated in an electrodeless high frequency gas discharge) or calf thymus DNA in aqueous solution was investigated. The loss of priming activity was compared with the appearance of single strand breaks in native and denatured DNA, double strand breaks, denatured zones, base damage, and rupture of hydrogen bonds. The primary lesions after exposure to H atoms and gamma radiation, respectively, are single strand breaks and base damage. Double strand breaks originating from accumulation of single breaks, and rupture of hydrogen bonds caused by single breaks and base damage, were identified as secondary lesions. In relation to strand breaks arising from radical attack on the sugar-phosphate backbone of the DNA molecule, base damage is about 12.5 times more frequent after H-exposure than after γ-irradiation. It is concluded from this observation, that single strand breaks are the predominant critical lesions responsible for the loss of the functional activity of DNA. (auth)

11958 THE MUTAGENIC ACTION OF 3,4-DIOXYPHENYL-ALANINE, ONE OF THE POSSIBLE MUTAGENS FORMED IN IRRADIATED TISSUES. Kopylov, V. A.; Yurov, S. S.; Veksler, A. M.; Kuzin, A. M. (Inst. of Biological Physics, Moscow). Dokl. Akad. Nauk SSSR; 187: 1404-7(21 Aug 1969). (In Russian).

Disturbances in the chromosome apparatus of γ-irradiated organisms due both to the incident ionizing radiation and to free radicals and radiotoxins, resulting from the radiation are discussed. The effect of the latter factor on the mutation was investigated, using 3,4-dioxyphenylalanine (DOPA) which is one of the polyphenyls found upon the irradiation of Vicia faba. Cultures of Escherichia coli were used for the experiment. It was found that DOPA in concentrations of 2.5×10^{-4} M created inverse mutations. Changes in the pH of the incubated medium affected only slightly the yield of the mutons. The result confirmed that the concentration of DOPA increased with the irradiation of the bacteria and DOPA-type radiotoxins were mainly responsible for the mutations. This compound may also induce natural, spontaneous mutations. (TTT)

11959 INACTIVATION BY IONIZING RADIATION OF ENZYME SOLUTIONS IN THE PRESENCE OF OTHER SOLUTES. Quintiliani, M.; Ebert, M. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). pp 15-22 of Radiation Damage and Sulphydryl Compounds. Vienna; International Atomic Energy Agency (1969).

From Panel on Radiation Damage to the Biological Molecular Information System with Special Regard to the Role of Sh-Groups, Vienna, Austria. See CONF-681069.

Irradiation of biologically important molecules in aqueous solution is particularly informative in the presence of added solutes. The mode of action of ionizing radiation can be demonstrated in some detail for the following concepts: electron transfer within large molecules; electron transfer between molecules; a form of radical transfer; and macromolecular conformation as a determinant of radiation sensitivity. (auth)

11960 EFFECT OF CYSTEAMINE AND AET ON THE RADIOLYSIS OF THYMINE IN AQUEOUS SOLUTION. Drasil, V.; Ryznar, L.; Van Duyet, P. (Inst. of Biophysics, Brno). pp 55-61 of Radiation Damage and Sulphydryl Compounds. Vienna; International Atomic Energy Agency (1969).

From Panel on Radiation Damage to the Biological Molecular Information System with Special Regard to the Role of Sh-Groups, Vienna, Austria. See CONF-681069.

Aqueous solutions of thymine in the presence and absence of oxygen were irradiated with ^{60}Co gamma radiation. The results showed that both AET and cysteamine decreased the proportion of thymine-hydroperoxide in the products of radiolysis. This protective phenomenon was observed even for irradiation in the absence of oxygen. In the latter case, there was also a relative decrease in the dihydrothymine content. This decreased amount of dihydrothymine in the radiolysis products may be due to either a competition between SH substances and the pyrimidine molecule for a hydrogen atom, or the fact that protective compounds increase the reverse reaction that is transformation of dihydrothymine into thymine. It was, however, shown that hydrogen atoms of $^{3}H_2O$ incorporated into thymine during the irradiation and that the course of the reverse reaction was not significantly affected by the presence of protective substances. It was concluded that the decreased content of dihydrothymine in irradiated solutions must be due to the competition for the hydrogen atoms by SH substances and pyrimidine. (auth)

11961 DNA REPAIR AND RADIOSENSITIVITY. Alexander, P. (Chester Beatty Research Inst., Belmont, Eng.). pp 63-81 of Radiation Damage and Sulphydryl Compounds. Vienna; International Atomic Energy Agency (1969).

From Panel on Radiation Damage to the Biological Molecular Information System with Special Regard to the Role of Sh-Groups, Vienna, Austria. See CONF-681069.

Cells exposed to x rays are capable of restoring by enzymatic processes many of the primary radiochemical changes produced in sub-cellular components. Physico-chemical techniques, especially alkaline sucrose gradient centrifuging, make it possible to follow the damage and repair of DNA molecules after irradiation in bacteria and mammalian cells. These findings show that the extent of the post-irradiation chemical damage to cells depends not on the magnitude of the primary lesion but on the extent to which these changes are restored. While radioprotective and radiosensitizing compounds can in model systems affect the magnitude of primary radiation damage, their effect on repair processes largely determines their capacity to alter radiation responses in vivo. Important features concerning the macromolecular structure of DNA, the attachment of DNA to membranes and the role of repair enzyme-ligase under normal conditions as well as after irradiation have been revealed by radiobiological investigations. (auth)

11962 EFFECTS OF IONIZING RADIATION ON THE PHOSPHORYLATION AND OXIDO-REDUCTION STATE OF THIOL GROUPS OF HISTONES, AND THEIR BIOCHEMICAL SIGNIFICANCE. Ord, Margery G.; Stocken, L. A. (Oxford Univ.). pp 111-15 of Radiation Damage and Sulphydryl Compounds. Vienna; International Atomic Energy Agency (1969).

From Panel on Radiation Damage to the Biological Molecular Information System with Special Regard to the Role of Sh-Groups, Vienna, Austria. See CONF-681069.

Studies on the radiosensitivity of ATP production by thymus nuclei led to an investigation of the role of thiol groups in nuclear proteins. About 50% of these thiol groups are associated with acid extractable proteins, predominantly the arginine-rich histone, F3. Irradiation of thymus nuclei causes an oxidation of thiol groups in this histone. Irradiation also produces an inhibition of ^{32}P uptake into phosphate groups into the lysine-rich histone F1. Histone F3 also carries phosphate groups but phosphorylation of this protein is not radiosensitive. Phosphorylation of histone F1 is particularly associated in mammalian cells with DNA synthesis; phosphorylation of F3 in regenerating liver may be linked to mRNA production. In mammalian cells the thiol + disulfide groups on histone F3 are mainly present as SH; in mature urchin eggs however, they are present as disulfide but are reduced to SH when structural changes are taking place in the nucleus and when DNA synthesis is occurring. The effects of ionizing radiation on regenerating liver are discussed relative to the changes in microstructure of the histones. (auth)

11963 THE EFFECTS OF LOCAL X IRRADIATION ON THE RELATIVE RATES OF INCORPORATION OF THYMIDINE-METHYL-5-^{3}H AND CYTIDINE-5-^{3}H INTO MITOCHONDRIAL AND NUCLEAR DNA OF MORRIS HEPATOMA 3924A. Looney, W. B.; Chang, L. O.; Morris, H. P. (Univ. of Virginia, Char-

lottesville. National Cancer Inst., Bethesda, Md.). Radiology; 93: 1159-65(Nov 1969).

No inhibition of the rate of incorporation of thymidine-5-methyl-^{3}H into mitochondrial DNA was produced from 1,500, 3,000, or 12,000 R of x radiation to rapidly growing and undifferentiated hepatomas (3924 A). At these three radiation doses, the rate of thymidine-5-methyl-^{3}H incorporation was reduced to 88, 95, and 60% of control values in the nuclear DNA fraction, respectively. It was found that the relative rates of cytidine-5-^{3}H incorporation into nuclear and mitochondrial DNA in normal liver and host liver as well as in hepatoma 3924 A are the reverse of those of thymidine-5-methyl-^{3}H. This is the result of a greater rate of incorporation into mitochondrial DNA as well as a smaller rate of incorporation into nuclear DNA. The rate of labeled-cytidine incorporation into both nuclear and mitochondrial DNA was depressed to a greater extent than labeled-thymidine incorporation at all three radiation doses. The differences in the rates of incorporation of labeled thymidine and cytidine into the mitochondrial DNA and nuclear DNA of the hepatoma might be explained in one of the following ways: First, the results would suggest that the mitochondrial pools for both cytidine-5-^{3}H and thymidine-5-methyl-^{3}H are different from the nuclear pools. These differences could also be related to the time of available labeled cytidine and thymidine, differences in membrane permeability, or differences in enzyme concentration involved in the conversion of labeled cytidine and thymidine into DNA precursors. However, the results of both the labeled cytidine and thymidine demonstrate that mitochondrial DNA synthesis is less affected by local x irradiation than is nuclear DNA synthesis. (auth)

11964 ^{226}Ra EFFECTS ON THE MUCOPOLYSACCHARIDES OF CARTILAGE. Tsai, Huan Chang C.; Della Rosa, R. J.; Rosenplatte, L. S.; Nix, Nancy (Univ. of California, Davis). Health Phys.; 18: 71-3(Jan 1970).

The effect of ^{226}Ra on collagen and mucopolysaccharides (hexosamine and hexuronic acid) has been studied for bone and cartilage of dogs. Samples of costal and articular cartilage and of rib bone of dogs after injections of ^{226}Ra were analyzed and the results are given. An apparent dose-related reduction was observed in the costal cartilage content of hexosamines and hexuronic acid. The reductions in hexosamine were shown to be due almost entirely to decrease in galactosamine. No change in hexosamine and hexuronic acid was found in rib bone and no difference in collagen in rib bone or costal and articular cartilage after ^{226}Ra treatment. (UK)

11965 PHOTOREACTIVATION OF ULTRAVIOLET LIGHT-INDUCED INHIBITION OF DNA SYNTHESIS IN TOBACCO CELLS GROWN IN VITRO. Trosko, J. E.; Mansour, V. H. (Michigan State Univ., East Lansing). Contract AT(11-1)-1704. Radiat. Bot.; 9: 523-5(Nov 1969).

On the basis of previous findings on bacteria it seems reasonable to assume that photoreactivation of UVL-induced pyrimidine dimers in tobacco cells led to removal of a UVL-induced inhibition of DNA synthesis. The experiment reported provides an observation in partial support of that assumption by the use of a modified technique to measure DNA synthesis in higher plants. (auth) (UK)

11966 ELONGATION AND SPECTROPHOTOMETRICALLY ASSAYABLE PHYTOCHROME OF X-IRRADIATED STEM SEGMENTS FROM ETIOLATED PISUM SATIVUM. Posner, H. B. (Brookhaven National Lab., Upton, N. Y.). Radiat. Bot.; 9: 353-5(Jul 1969).

Tanada reported that low doses of X-rays inhibited the photoreversible attachment of barley root tips to wet glass surfaces, and suggested that damage to phytochrome might have been involved. Some results obtained at Brookhaven National Laboratory suggest that spectrophotometrically assayable phytochrome in vivo is extremely radioresistant, much more so than the growth of the tissue. These studies are described and the results discussed. (auth) (UK)

11967 SOME MEIOSIS DISTURBANCE IN COTTON PLANTS M_1 AS AFFECTED BY GAMMA RADIATION AND DIMETHYL SULPHATE. Vorob'eva, G. A.; Egamberdiev, A. E. (Inst. of Experimental Biology of Plants, Tashkent). Uzb. Biol. Zh.; No. 5, 48-50(1969). (In Russian).

Meiosis disturbance was studied in M_1 plants following combined γ-ray and dimethyl sulfate seed treatment and following γ rays and dimethyl sulfate given separately. Meiosis rate changes, disturbances in the sequence of nuclear divisions, and in location of partitions during tetrad formations were established. Cytomixis is one of the indexes of the sharp change in plant physiological state. (auth)

11968 RADIATION PRODUCED AGGREGATION IN CRYSTALLINE PREPARATIONS OF RIBONUCLEASE, LYSOZYME, AND TRYPSIN. Stevens, C. O.; Long, J. L.; Upjohn D. (Fitzsimons General Hospital, Denver). Proc. Soc. Exp. Biol. Med.; 132: 951-6(Dec 1969).

Soluble and insoluble aggregates are major inactive radiation products in vacuo from crystalline lysozyme, ribonuclease, and trypsin. Soluble aggregates can be cleanly separated from active monomer materials by gel filtration on P-100 columns. This separation also permits quantitation of aggregate formation. Such products increase with increasing dose. If H_2S is present during radiation, aggregate yield is decreased in ribonuclease and increased in lysozyme and trypsin. In the case of the latter two enzymes aggregates produced in the presence of H_2S retain significant activity levels. These results indicate the free radical scavenger, H_2S, promotes aggregate formation from active monomers in which free radicals have been produced by irradiation. (auth)

11969 CONTENT OF THE ACID-SOLUBLE NUCLEOTIDES IN THE SPLEEN OF GAMMA-IRRADIATED RATS AT VARIOUS RATES OF THE DOSE. Geshanova, E. (Inst. of Comparative Pathology of Animals, Sofia). Compt. Rend. Acad. Bulg. Sci.; 22: 801-3(1969).

Two groups of rats were given a dose of γ radiation; the dose was given to one group at a rate of 200 R/min and to the second group at a rate of 900 R/min. Six days later spleen tissue was removed and separation of nucleotides was carried out by paper chromatography. The contents of adenine, guanosine, and uridine nucleotides following irradiation at both dose rates as well as contents of unirradiated controls are tabulated. Results show that the 900 R/min dose rate caused greater changes in the content of nucleotides. (H.L.W.)

11970 CHANGE IN THE CONTENT OF THIOL GROUPS IN PROTEINS OF THE GLOBULIN FRACTION FROM LIVER CELL NUCLEI OF X-IRRADIATED RATS. Kedrova, E. M.; Rodionov, V. M. (Inst. of Biological and Medical Chemistry, Moscow). Biochemistry (USSR) (Engl. Transl.); 34: 270-3(Mar-Apr 1969). Translated from Biokhimiya; 34: 340-4(Mar-Apr 1969).

The content of SH-groups in nuclear globulins isolated from regenerating rat liver was found increased, compared to its content in the corresponding proteins of intact liver. Immediately after x-ray irradiation at a 1500 R dose, the content of SH-groups in RNP and in the salt soluble proteins of cell nuclei decreased both in intact and regenerating liver. After irradiation, the amount of SH-groups in RNP returned to initial levels after one hour. In the salt-soluble proteins, SH-group content had failed to return to normal after 2 days. (auth)

Immunology

Refer also to abstracts 12187, 12225, 12285, and 12300.

11971 (CEA-R-3901) A STUDY OF THE BEHAVIOUR OF IRRADIATED OR UNIRRADIATED GRAFTS IN THE CAMERA AQUOSA OF IRRADIATED AND UNIRRADIATED ANIMALS. Djalali-Behzad, Gholamreza (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Nov 1969. 55p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Univ. of Paris, Orsay, France.

The growth of irradiated and non-irradiated bone marrow grafts in the anterior eye chamber was studied in mice and rats. Newborn mice were exposed to whole-body x radiation at doses of 200, 600, and 800 R and their bone marrow was used as grafts in heterologous and isologous adult mice. All irradiated bone marrow grafts survived. Non-irradiated bone marrow grafts failed to survive in rats exposed to 700 R whole-body γ radiation before grafting. It was concluded that toxic effects of radiation acted on the grafts after vascularization so that they were unable to grow. (C.H.)

11972 (NYO-3808-2) DIRECT, LONG-TERM OBSERVATION OF HEMATOPOIETIC MARROW. Annual Report, September 25, 1967-September 25, 1968. (New England Medical Center Hospitals, Boston, Mass.). Contract AT(30-1)-3808. 10p. Dep. CFSTI.

Efforts to define the conditions that support the reconstitution of implanted marrow are described in relation to the following studies: microscopy of marrow in vivo, size and shape of transplanted nodules of marrow, the relation between red marrow and yellow marrow, and the transformation of yellow marrow to red marrow. The effects of x irradiation on the subcutaneous implantation of bone marrow, the effect of cell dispersion in autologous marrow transplants, hematopoietic regeneration in irradiated tibias following transplantation of bone marrow, and injury and repair of marrow tissue within the bone were also studied. Results of these studies produced a standardized model of marrow transplantation in extramedullary sites. (C.O.)

11973 (NYO-3808-3) DIRECT, LONG-TERM OBSERVATION OF HEMATOPOIETIC MARROW. Annual Report, September 25, 1968-September 25, 1969. (New England Medical Center Hospitals, Boston, Mass.). Contract AT(30-1)-3808. 11p. Dep. CFSTI.

Progress is reported for studies concerned with the determination of factors required for optimal reconstruction of extramedullary marrow implants, visualization of the marrow in vivo, adaptation of the model of marrow transplantation for clinical use in human subjects with aplastic anemia, analysis of the origin of the cells responsible for initiation of the regenerative process and the formation of osteogenic as well as hemopoietic tissues, and the behavior of yellow and red marrow in extramedullary marrow implants. Mustard gas and x rays were used in the study for analysis of the origin of cells responsible for initiation of the regenerative process (mesenchymal cells) and the formation of osteogenic and hemopoietic tissues. Collateral studies with other tissues are also described and discussed. A list of the publications (5) that resulted from these studies is included. (C.O.)

11974 (ORO-672, pp 40-2) INDUCTION OF PHYSIOLOGICAL CHANGES BY TREATING THE EMBRYO AND EARLY FETUS OF COW AND SHEEP. Cragle, R. G. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

Studies centering on the induction of chimerism in the 0 to 40-day-old fetus in cattle and sheep are described. To date, no data have been collected. The work with reciprocally transplanted kidneys between fraternal twin pairs remains in the observation phase; functional kidneys have been maintained for from 34 to 41 months. Cumulative radiation exposure data of these chimeric cattle are presented in tabular form. (C.O.)

11975 (STI/PUB-181) ISOTOPES AND RADIATION IN PARASITOLOGY. Panel Proceedings Series. Proceedings of the Research Co-ordination Meeting Held in Vienna, 31 July-4 August 1967. (International Atomic Energy Agency, Vienna (Austria)). May 1968. 163p. (CONF-670738). IAEA $3.50.

Separate abstracts were prepared for 14 of the 16 papers presented at the conference. Effects of radiation on immune reactions of the host to parasitic infections are emphasized. (H.L.W.)

For abstracts of individual papers see: 11921, 11922, 12010-12015, 12188, 12189, 12224-12226, and 12300.

11976 THE DEVELOPMENT OF CLONES OF ANTIBODY-FORMING CELLS IN THE SPLEENS OF IRRADIATED MICE. II. SOME PROPERTIES OF PLAQUE-FORMING CELL COLONIES AND EVIDENCE FOR THEIR CLONAL NATURE. Cunningham, A. J. (Walter and Eliza Hall Inst. of Medical Research, Parkville, Australia). Aust. J. Exp. Biol. Med. Sci.; 47: 493-503 (Aug 1969).

Localized concentrations of 19S antibody plaque-forming cells developed in the spleens of lethally irradiated mice which had been injected with syngeneic spleen cells and sheep erythrocytes. Numbers of plaque-forming cells in such colonies ranged from 28,000 down to less than 40, the largest aggregations appearing after 6-8 days of culture. Evidence that these colonies were clones came from the finding that, in most cases, all the cells in any one colony released antibody of apparently identical specificity. In addition, the appearance of the plaques themselves was often conspicuously uniform within a colony. Individual plaque-forming cells were obtained from 9 colonies by micromanipulation and examined morphologically. In 4 cases all the cells examined from a single colony were closely similar in appearance. Localized concentrations of cells producing 7S antibody were also found, although these were relatively uncommon. Nearly half of the 7S colonies appeared in the same spleen segments as 19S colonies, statistically a highly significant association which supports the idea of a 19S antibody switch in the differentiation of some antibody-forming cell clones. (Australia)

11977 THE DEVELOPMENT OF CLONES OF ANTIBODY-FORMING CELLS IN THE SPLEENS OF IRRADIATED MICE. I. DETECTION OF PLAQUE-FORMING CELL COLONIES, AND THEIR RELATIONSHIP TO HAEMOLYTIC FOCI. Cunningham, A. J. (Walter and Eliza Hall Inst. of Medical Research, Parkville, Australia). Aust. J. Exp. Biol. Med. Sci.; 47: 485-92 (Aug 1969).

A markedly non-random distribution of antibody-plaque-forming cells was found in the spleens of lethally irradiated mice which had been injected 5 to 10 days previously with sheep erythrocytes and 1 to 2×10^6 syngeneic spleen cells. Localized concentrations (colonies) of 19S and 7S plaque-forming cells were identified by cutting the spleens transversely into 8 pieces, making dispersed-cell suspensions from these segments, and testing the suspensions directly with the hemolytic plaque technique. The colonies had an average length of approximately 0.5 mm, with an upper size limit of about 1.5 mm. There was little correlation between the position of these colonies and the position of local concentrations of hemolytic antibody detected by a hemolytic focus method. (Australia)

11978 THE RESPONSE OF BHK21 CELLS TO INFECTION WITH TYPE 12 ADENOVIRUS. 1. CELL KILLING AND T ANTIGEN SYNTHESIS AS CORRELATED VIRAL GENOME FUNCTIONS. Strohl, William A. (Rutgers-The State Univ., New Brunswick, N. J.). Virology; 39: 642-52(Dec 1969).

In cultured BHK21 cells, killing by type-12 adenovirus (Ad-12) was shown to be a viral genome function, to require only one successfully infecting virus particle, and to be induced with an efficiency somewhat greater than the initiation of viral early protein synthesis, measured as Ad-12 tumor-specific antigen (T Ag). When the multiplicity of infection is increased beyond that required to initiate T Ag synthesis in 98% of the cells, a persistent surviving fraction of cells is found, the magnitude of which is dependent on the extent and rate of cell multiplication during the first 24 hours after infection. Analysis of T Ag synthesis in clones produced by infected cells indicates that while infected cells can divide initially, the capacity to synthesize T Ag is not replicated, since the multiplying cells are all T Ag (-) even though they may be the offspring or sisters of T Ag (+) cells. While single T Ag (+) cells may persist for several days after infection, most of these detach from the coverslip within 24 to 48 hours after infection and can no longer give rise to clones. The increased survival of cells infected at high multiplicity while in logarithmic growth can be accounted for only by dilution of the infecting genomes and is not caused by a genetically resistant cell type in the population. The effects of x-irradiated feeder cells on cell multiplication were also studied. (C.H.)

11979 FURTHER STUDIES ON SERUM PROTEIN FORMATION BY CHIMERAS. III. IN VITRO FORMATION OF SERUM PROTEINS OF DONOR ORIGIN BY XENOGENEIC HAMSTER-MOUSE CHIMERAS. Phillips, Mildred E. (New York Univ., N. Y.). Exp. Hematol.; No. 19, 42-5(1969).

The synthesis of donor-type serum proteins by the lymphoid tissues of mice receiving hamster bone-marrow cells was demonstrated. The recipients were given 850 R x irradiation followed within 2 hr by intravenous injection of xenogenic bone marrow. All the chimeras died within 4 weeks, the majority during the second or third weeks. Some of the mouse sera contained hamster haptoglobin-hemoglobin complex. Immunoelectrophoretic examination failed to reveal any other hamster serum protein, including gamma-globulin. Hamster transferrin was not demonstrated in the sera, but fluids from spleens and lymph nodes cultured from the chimeras showed labeling of both hamster and mouse transferrin. No other labeled hamster proteins were demonstrated in the culture fluid. (M.M.B.)

11980 INFLUENCE OF LYMPHOPOIESIS CONTROL MECHANISMS ON THE RECOVERY OF IMMUNE CAPACITIES IN ISOGENIC RADIATION CHIMERAS. Duplan, J. F. (Institut du Radium, Paris). pp 349-61 of Effects of Radiation on Cellular Proliferation and Differentiation. Vienna; International Atomic Energy Agency (1968). (In French).

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco. See STI/PUB-186; CONF-680413.

The capacities of cells belonging either to fetal liver or to adult bone marrow or spleen are extremely different as far as the production of immunologically competent cells (ICC) by isogenic chimeras is concerned. The study of thymectomized radiation chimeras by the Simonsen test and the Jern technique shows that it is only the spleen or the lymph nodes that are able to bring ICC to a thymectomized animal; the bone marrow and the fetal liver carry only precursor cells that cannot be transformed into ICC when the recipient lacks its thymus. Furthermore, the functional ICC brought to these animals by the spleen cell suspensions have a limited life span, not exceeding 300 to 400 days. It must also be stressed that the thymectomized isogenic chimeras treated by bone marrow or fetal liver, although they display no immune reactivity, have an increased production of immunoglobulins. Therefore it seems that in this case there is no regulation of the production, differentiation, and maturation of ICC. However, a control of the production and the reactivity of ICC does exist in non-thymectomized radiation chimeras. This can be shown by the Simonsen test and the Jern technique for the primary reactions and by the study of homologous tumor graft rejection for the second-set reaction. This regulatory activity could be mediated either through a feed-back mechanism acting on ICC production or through a more complex process involving an interaction between antigens and cells. (auth)

11981 DETECTION OF POTENTIALLY COMPETENT CELLS IN THE THYMUS OF LETHALLY IRRADIATED MICE AFTER

BONE-MARROW TRANSPLANTATION. Agarossi, Giovanna; Doria, G. (CNEN–EURATOM, Rome). pp 363-8 of Effects of Radiation on Cellular Proliferation and Differentiation. Vienna; International Atomic Energy Agency (1968).

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco. See STI/PUB-186; CONF-680413.

Previous studies on adoptive immunity in irradiated mice indicated that the thymus acts on potentially competent (PC) cells by promoting the differentiation of thymus-dependent (PC_0) to thymus-independent (PC_1) cells. Whether such a differentiation occurs in the thymus was investigated by the following experiments. Normal bone-marrow cells that were fully thymus-dependent, were transplanted into isogenic, lethally whole-body x-irradiated mice. At different times after transplantation, cells from the thymus of these chimeras were grafted into isogenic thymectomized and non-thymectomized, lethally irradiated recipients, and stimulated with sheep RBC. Thymus-dependence of the immune response of donor cells was assessed by enumeration of anti-sheep RBC hemolysin-forming cells in the spleens of both thymectomized and non-thymectomized recipients. The thymus of 15- and 30-day-old chimeras contained potentially competent cells. (auth)

11982 DYNAMICS OF CELLULAR PROLIFERATION DURING ACUTE HOMOLOGOUS DISEASE IN MICE. Vitale, B.; Silobrcic, V.; Jurin, M.; Matosic, M.; Tomazic, Vesna (Inst. Ruder Boskovic, Zagreb). pp 395-409 of Effects of Radiation on Cellular Proliferation and Differentiation. Vienna; International Atomic Energy Agency (1968).

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco. See STI/PUB-186; CONF-680413.

CBA mice, lethally γ-irradiated and injected with 20×10^6 bone-marrow cells derived from C57BL donors, develop a chronic form of homologous disease and die between 20 and 40 days after treatment. If 10×10^6 lymph node cells are added to the bone-marrow suspension, all recipients develop acute homologous disease and die 6 to 10 days after irradiation. Different parameters of the disease were systematically observed. Among them, changes in spleen weight indicated early cell proliferation that reached its maximum on day 4 and progressively decreased later on. Chromosomal analysis showed that all dividing cells in the spleen were of donor origin. Their number decreased concomitantly with the shrinkage and devastation of the organ, which started on day 6. The period of devastation of the spleen fully corresponds to the time in which all animals die. The use of cyclophosphamide in the treatment of acute homologous disease transformed the disease into a chronic form with a mortality very similar to that obtained when only bone-marrow cells were injected. Among other effects, treatment with cyclophosphamide prevented early proliferation of donor cells in the spleen, and delayed spleen weight increase for about 10 days. After that period spleen weight increased, reaching its maximum on day 12. At first only donor type cells could be detected, but towards the end of the period in which spleen weight increase was registered host type cells appeared among the cells in mitosis. Their number gradually increased, and in some cases the majority or all of the dividing cells were of the host type. After a transitional decrease in spleen weight, another peak in cellular proliferation consisting of either host or donor or both types of cells was observed about day 30. In spite of the observed irregularities in the origin of dividing cells, all animals died by day 40 after application of cyclophosphamide. The relationship between proliferation of injected lymph node and bone-marrow cells and spleen-weight increase is discussed together with relationship between spleen devastation and mortality. (auth)

11983 REACTIVATION OF IMMUNOLOGICAL RESPONSE IN LETHALLY X-IRRADIATED MICE TREATED WITH ISOGENEIC BONE MARROW. Stankovic, V.; Slijepcevic, M.; Hrsak, I. (Inst. Ruder Boskovic, Zagreb). pp 411-20 of Effects of Radiation on Cellular Proliferation and Differentiation. Vienna; International Atomic Energy Agency (1968).

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco. See STI/PUB-186; CONF-680413.

Male and female C57BL/H and CBA/H mice aged 10 to 12 weeks were used as recipients and donors, respectively. All recipient mice were given a lethal whole-body x irradiation (850R for C57BL and 950R for CBA mice) followed by iv injection of 10×10^6 isogenic eosin-negative bone-marrow cells suspended in 0.5 ml of Hank's solution. The number of eosin-positive cells was less than 10%. The state of immunological responsiveness of irradiated recipients was measured at different time intervals up to 86 days after irradiation. The immune response to bacterial antigen was measured with the titre of agglutinating antibodies in serum six days after iv antigenic stimulation with a suspension of 2×10^7 killed Salmonella typhimurium cells. The immune response to tissue antigens was evaluated by: the effectiveness of the spleen cells from isologous radiation chimeric parental mice in preventing bone marrow from F_1(C57BL × CBA) hybrid donor from therapeutically affecting lethally irradiated F_1 recipient mice; and the effectiveness of the spleen cells in inducing splenomegaly in recipient F_1 hybrid mice (Simonsen test). The responsiveness to bacterial antigens reappeared earlier and increased faster than the immunological responsiveness to tissue antigens. (auth)

11984 PROCEEDINGS OF THE SECOND INTERNATIONAL CONGRESS OF THE TRANSPLANTATION SOCIETY, NEW YORK, SEPTEMBER 7–11, 1968. PART I. Transplant. Proc.; 1: 1-330(Mar 1969). (CONF-680922-(Pt.1)).

Separate abstracts were prepared for six of the 62 papers included in part I of these proceedings. The symposia and forums at the conference dealt with transplantation of bone marrow, organs, and kidneys; pregnancy and transplantation; cancer, immunology, and transplantation; and organ preservation. (M.M.B.)

For abstracts of individual papers see: 11985–11990.

11985 EXPERIMENTAL ASPECTS OF BONE MARROW TRANSPLANTATION IN PRIMATES. van Bekkum, D. W.; Balner, H.; Dicke, K. A.; van Putten, L. M. (Radiobiological Inst. TNO, Rijswijk, Netherlands). Transplant. Proc.; 1: 25-30(Mar 1969).

From 2nd International Congress of the Transplantation Society, New York. See CONF-680922-(Pt.1).

The most recent developments in bone marrow transplantation in monkeys are reviewed. Secondary disease in the primate after allogenic bone-marrow transplantation is uniformly more difficult to influence than in rodents. Partial control of the acute phase in monkeys was achieved by post-transplantation treatment with cyclophosphamide as well as with anti-lymphatic serum. Encouraging results were obtained by the separation of lymphoid cells from hemopoietic stem cells, evidenced by the fact that recipients treated with stem-cell concentrates demonstrated a delayed development of the secondary syndrome. It is likely that further improvements will be obtained by selecting bone marrow donors compatible for leucocyte and possibly erythrocyte antigen groups. The number of isogenic cells needed to protect lethally irradiated monkeys is 4×10^7/kg as compared to 5×10^6/kg for mice and about 1×10^8/kg for man. (M.M.B.)

11986 SYMPOSIUM ON BONE MARROW TRANSPLANTATION: EXPERIMENTAL ASPECTS IN CANINES. Thomas, E. Donnall; Storb, Rainer; Epstein, Robert B.; Rudolph, Robert H. (Univ. of Washington, Seattle. Public Health Service Hospital, Seattle). Transplant. Proc.; 1: 31-3(Mar 1969).

From 2nd International Congress of the Transplantation Society, New York. See CONF-680922-(Pt.1).

Long-term radiation chimeras were achieved using disease-free dogs in isolation and methotrexate treatment for several days after marrow grafting. When adequate numbers of marrow cells (10^{10} or greater) and proper techniques were used the results were consistently good, although some animals died either from secondary disease or after graft rejection. Dogs with allogenic marrow grafts that lived beyond 120 days regained their health and did not show any late radiation effects other than greying of hair. A combination of aspirated bone marrow plus buffy coat cells was found effective for allogenic grafts and could be obtained without sacrificing the donor. Marrow was still effective after freezing in dimethyl sulfoxide. Lymphocyte typing by cytotoxic isoantisera was useful for predicting the success of a graft. Paired litter mates were irradiated with 600 R (LD_{100}). When one of the pair was treated with allogenic marrow no significance differences in hematological parameters or survival were observed between the two groups. A 100 mg per kg dose of cyclophosphamide was lethal unless followed by treatment with the dogs own marrow removed and frozen prior to administration of the drug. When a lethal dose of cyclophosphamide was followed by an infusion of allogenic bone marrow obtained from matched litter mates, the graft took in five of 18 treated dogs. In contrast to radiation chimeras that showed only donor bone marrow cells, these dogs had mixtures of donor and host marrow cells. (M.M.B.)

11987 EFFECT OF SYNGENEIC ANTILYMPHOCYTE SERUM ON RAT–MOUSE RADIATION CHIMERAS. A PRELIMINARY REPORT. Gengozian, N.; Congdon, C. C. (Oak Ridge Associated Universities, Tenn.). Transplant. Proc.; 1: 34-8(Mar 1969).

From 2nd International Congress of the Transplantation Society, New York. See CONF-680922-(Pt.1).

In xenogenic rat-mouse chimeras, sporadic, spontaneous reversions to host hematopoietic systems were observed infrequently. Attempts were made to induce such reversions to host-type cells.

Mouse lymphoid cell injections caused some x-radiation (whole-body, 950R or 1100R) rat-mouse chimeras to revert to mouse-type erythrocytes. Mouse anti-rat lymphocyte serum was injected into 20 mouse-rat chimeras. None showed any evidence of replacement of rat hematopoietic tissue by mouse elements. The major pathology of these chimeras at autopsy was bone-marrow necrosis and depletion of lymphatic tissues. (M.M.B.)

11988 IMMUNOLOGICAL CONSIDERATIONS OF BONE MARROW TRANSPLANTATION. Uphoff, Delta E. (National Cancer Inst., Bethesda, Md.). Transplant. Proc.; 1: 39-43(Mar 1969).

From 2nd International Congress of the Transplantation Society, New York. See CONF-680922-(Pt.1).

Bone marrow transplantation studies in lethally irradiated inbred mice were used as a method for obtaining information on the immune response. Various methods were used to expose stem cells to antigens prior to transplantation. In vitro exposure of mixtures of marrows of different genotypes to allogenic cells or antigens decreased radiation protection by the pool. Surviving chimeras were often of mixed genotype even though neither the irradiated recipient nor the donor strains were related. Contact time and temperature affected the protective capacity of syngenic marrow preincubated with allogenic erythrocytes. Surviving syngenic chimeras were tolerant to skin allografts of the erythrocyte donor strain. Allogenic marrow was also modified by in vitro contact with erythrocytes from strains of the recipient or of reciprocal hybrid origin. This alteration of the marrow was reflected by increased late mortality and was considered a sensitization process. The ability of stem cells to distinguish between cells from reciprocal hybrids was also demonstrated by a reduction of the incidence of thymic lymphomas in AKR recipients when CBA donor marrow was preincubated with CBA or (CBA × AKR) F_1 erythrocytes. No significant reduction occurred when preincubation was with (AKR × CBA) F_1 erythrocytes. This reduced incidence of thymic lymphomas was not due to transplant failure, but to a secondary destruction of the thymus. Reduced protective capacity, increased late mortality, and thymic destruction were all immunogenetic in origin and occurred as a result of an interaction between the marrow cell and the erythrocytes. Since neonatal induction of tolerance and in vitro incubation of marrow with allogenic erythrocytes both produced skin allograft tolerance and reduced the protective capacity of some syngenic marrows, it was postulated that both of these processes resulted in an alteration of the stem cells so that they no longer recognized the allogenic strain as foreign or the syngenic strain as self. Further implications of these results are discussed. (M.M.B.)

11989 CURRENT PROBLEMS OF TISSUE BANKING. Ostrowski, K. (Medical Academy, Warsaw). Transplant. Proc.; 1: 126-31(Mar 1969).

From 2nd International Congress of the Transplantation Society, New York. See CONF-680922-(Pt.1).

Problems involved with the preservation of tissue in banks are discussed. It is suggested that there be Transplantation-Society sponsored international cooperation among tissue banks. Lyophilization and radiosterilization appears to be the most useful method for preservation of tissues in banks. The sterility of grafts were well controlled, although, some problems remain concerning the detection of viruses and their resistance to radiation. Other problems of this method are changes in physical properties in lyophilized and irradiated tissues. There may be changes in mechanical properties and changes at the molecular level. After irradiation, free radicals may persist in tissue for months or years. Two types of electron spin resonance signals were detected in irradiated bone. One, a stable signal, was identified as a radical derived from hydroxyapatite. The other signal, which was short-lived in oxygen, appeared to be connected with collagen. Denaturation of proteins with resulting changes in solubility and enzymatic activity may occur after freezing or irradiation. It was shown that alkaline phosphatase and aldolase in bone are unusually radioresistant. Lyophilized and irradiated bone showed lowered antigenicity when measured by the quantitative regional lymph node reaction. Further research should consider preservation of living organs, living cells, and stimulation of reparative or regenerative properties in the host. (M.M.B.)

11990 MECHANISM OF CANINE RENAL ALLOGRAFT REJECTION. Foker, J. E.; Clark, D. S.; Pickering, R. J.; Good, R. A.; Varco, R. L. (Univ. of Minnesota, Minneapolis). Transplant. Proc.; 1: 296-300(Mar 1969).

From 2nd International Congress of the Transplantation Society, New York. See CONF-680922-(Pt.1).

An attempt was made to isolate the components associated with the allograft rejection reaction. Adult dogs were used as kidney donors and allograft recipients. The transplanted kidneys were sutured to the neck vessels of the recipients. A kidney was transplanted from dog A to dog B where it remained for 24 hr or 4 days. The graft was then removed and dog B was exposed to 600 R whole-body x irradiation. After dog B became leukopenic, the second kidney from dog A was implanted into dog B where it remained for 4 hr after which it was returned to the donor. Control experiments differed in the origin of the second kidneys which came from dogs unrelated to the original donors (C). Biopsies revealed good renal structure without significant polymorphonuclear leukocyte (PMN) infiltration after residence in irradiated leukopenic dogs B. However, within 4 hr after return to donor dogs all 12 kidneys showed significant interstitial PMN infiltration. In contrast, only 2 out of 10 control kidneys had PMN infiltration after implanting in dogs C. This latter incidence of rejection would be expected from fortuitous crosc-reactions alone. Within 12 hr, 8/12 test kidneys stopped urine production and had extensive histological tubular disruption, while 8/10 control kidneys still produced urine after 24 hr. Complement uptake by test kidneys became significantly higher in test kidneys after return to the original donor. Depression of complement levels in dogs A and B with cobra venom reduced PMN infiltration and prevented graft destruction. (M.M.B.)

11991 PROCEEDINGS OF THE SECOND INTERNATIONAL CONGRESS OF THE TRANSPLANTATION SOCIETY, NEW YORK, SEPTEMBER 7-11, 1968. PART II. Transplant. Proc.; 1: 331-682(Mar 1969). (CONF-680922-(Pt.2)).

Separate abstracts were prepared for nine of the 83 papers included in part II of these proceedings. Topics included are transplantation genetics, histocompatibility testing, heterologous anti sera, transplantation antigens, serum components in transplantation, and immunobiology. The final symposium was concerned with current horizons in transplantation. (M.M.B.)

For abstracts of individual papers see: 11992-12000.

11992 HISTOCOMPATIBILITY TYPING OF INBRED MICE FOR KNOWN NON-H-2 ALLELES. Graff, Ralph J.; Snell, George D. (Jewish Hospital, St. Louis. Jackson Lab., Bar Harbor, Maine). Transplant. Proc.; 1: 362-4(Mar 1969).

From 2nd International Congress of the Transplantation Society, New York. See CONF-680922-(Pt.2).

Skin grafts and transplantable x-radioinduced leukemias were used to test for the distribution of autosomal histocompatibility loci in commonly used inbred strains of mice. The alleles of eight of these non-H-2 loci are described in 17 strains of mice. (M.M.B.)

11993 ANTIBODY PLAQUE REDUCTION IN VITRO AND IN VIVO: A RAPID ASSAY FOR IMMUNOSUPPRESSIVE AGENTS. Gavin, John; Waterbury, Walter; Freidman, Herman (Dome Labs., West Haven, Conn. Albert Einstein Medical Center, Philadelphia). Transplant. Proc.; 1: 413-15(Mar 1969).

From 2nd International Congress of the Transplantation Society, New York. See CONF-680922-(Pt.2).

The effects of immunosuppressive agents on the antibody-plaque response of mice was tested. In in vivo experiments, mice were treated with the test agent prior to challenge with sheep erythrocytes. The number of plaque forming cells (PFC) was determined in individual spleens 4 days later. The agents were effective if they were administered prior to immunization. There was a 50 to 90% suppression in the expected PFC response when mice were treated with 1 to 2 mg of Amethopterin, cyclophosphamide, 5-fluorouracil, 6-mercaptopurine, vinblastine A, or cortisone acetate. Mice receiving 400R or more of whole-body x irradiation 1 day before immunization had a 99% decrease in PFC response. The secondary immune response appeared to be more resistant to suppression. X irradiation, cortisone, 6 mercaptopurine, 5-fluorouracil, and cyclophosphamide were less suppressive on antibody formation by cells from immune donors maintained in vitro. For example, 5000R x irradiation was needed to achieve 50% suppression in vitro. (M.M.B.)

11994 INDUCTION OF TOLERANCE WITH ANTILYMPHOCYTIC SERUM. Lance, E. M.; Medawar, P. B. (National Inst. for Medical Research, London). Transplant. Proc.; 1: 429-32 (Mar 1969).

From 2nd International Congress of the Transplantation Society, New York. See CONF-680922-(Pt.2).

A summary of research on the use of antilymphocyte serum (ALS) as an immunosuppressive agent is presented. Adult CBA mice were given A strain tail-skin homografts and a course of injections of rabbit ALS. The tolerance conferring stimulus was an injection of lymphoid cells from (CBA × A) F_1. The relative timing of these procedures was important for the character and magnitude of the host's response. Immune tolerance was induced by a series of ALS injections followed by lymphoid cells, but the

median survival time of grafts was only 100 to 200 days. When mice were treated with irradiation (450R) or cyclophosphamide (100 mg/kg) after the completion of a course of ALS, but before the injection of lymphoid cells, the median survival time was increased. (M.M.B.)

11995 CELL TO CELL INTERACTION IN THE IMMUNE RESPONSE. Miller, J. F. A. P.; Mitchell, G. F. (Royal Melbourne Hospital, Victoria). Transplant. Proc.; 1: 535-8(Mar 1969).

From 2nd International Congress of the Transplantation Society, New York. See CONF-680922-(Pt.2).

The defective response of neonatally thymectomized mice to sheep erythrocytes (SRBC) can be reversed by thymus cells or by thoracic duct lymphocytes. The 19S hemolysin-forming cells (PFC) arising in the spleens of allogenically reconstituted mice appear to be derived not from the inoculated lymphoid cells but from a cell type already in the thymectomized host. Experiments were undertaken to determine the role of the intact and viable thymus or TDL that are essential for their host to respond normally to SRBC. Irradiated recipients of lymphoid cells from various sources were used to identify the precursors of the PFC. It was concluded that PFC precursors are derived from bone marrow but that their differentiation in response to SRBC requires thymus-derived cells. The property of tolerance appears to be linked to thymus-derived cells, but its relation to bone-marrow derived-cells was not determined. (M.M.B.)

11996 GENETIC CONTROL OF THE ANTIBODY RESPONSE TO A SYNTHETIC POLYPEPTIDE: TRANSFER OF RESPONSE WITH SPLEEN CELLS OR LYMPHOID PRECURSORS. Tyan, Marvin L.; McDevitt, Hugh O.; Herzenberg, Leonard A. (Naval Radiological Defense Lab., San Francisco. Stanford School of Medicine, Palo Alto, Calif.). Transplant. Proc.; 1: 548-50(Mar 1969).

From 2nd International Congress of the Transplantation Society, New York. See CONF-680922-(Pt.2).

Experiments were designed to determine whether the genetic control of the antibody responses of certain strains of mice to a series of multi-chain synthetic polypeptide antigens is related to the process of antibody formation, and if so through which cell type(s) this control is expressed. When spleen cells from responding mice were transferred to lethally irradiated nonresponding mice, the antibody response was characteristic of the donor strain. Thymectomized or normal lethally irradiated responding mice were given liver cells and sometimes a thymus transplant from nonresponding fetuses and then immunized with antigen. Experiments were also performed in which the donors were nonresponders and the recipients were responders. The data indicate that the genetic control of the ability to respond to these antigens is exerted through a mechanism directly related to antibody formation and suggest that this control is expressed through a cell type(s) other than those produced by the thymus or the antibody-forming cell or its direct precursor. (M.M.B.)

11997 SPECIFICITY OF THE IN VITRO RESPONSE OF ANTIGEN-SENSITIVE UNITS TO TWO ANTIGENS. Osoba, David (Univ. of Toronto. Ontario Cancer Inst., Toronto). Transplant. Proc.; 1: 567-70(Mar 1969).

From 2nd International Congress of the Transplantation Society, New York. See CONF-680922-(Pt.2).

Cell culture experiments are described in which a single precursor was exposed simultaneously to two non-cross-reacting antigens. Spleen cells from unimmunized mice were cultured and after exposure to antigens they were assayed for plaque-forming cells (PFC). The antigens used were chicken-red-blood cells (CRBC) and sheep-red-blood cells (SRBC). When spleen cells in numbers less than 10^7 were mixed with antigen no PFC response occurred unless 2×10^7 irradiated (1000 rads) spleen cells are included in the culture material. It was, therefore, possible that at limiting dilutions some of these cultures would contain only one precursor capable of responding to only one antigen. The frequencies of the response of such cultures to the two antigens were different. In addition, some cultures contained PFC against CRBC, some against SRBC, some against neither, and some against both. These results indicate that the precursors for these two antigens belong to separate and independent populations of cells. (M.M.B.)

11998 SKIN ALLOGRAFT SURVIVAL IN LYMPHOCYTE-DEPLETED CALVES. Chanana, A. D.; Cronkite, E. P.; Joel, D. D.; Schiffer, L. M. (Brookhaven National Lab., Upton, N. Y.). Transplant. Proc.; 1: 583-5(Mar 1969).

From 2nd International Congress of the Transplantation Society, New York. See CONF-680922-(Pt.2).

Repetitive daily extracorporeal irradiation of the blood (ECIB) despite the production of marked and sustained lymphocytopenia, results only in modest prolongation of skin allograft survival. Thymectomy in 56- to 205-day-old calves resulted in lymphocytopenia, and ECIB in thymectomized calves produced a further marked drop in blood lymphocytes, but the addition of thymectomy did not improve the skin allograft survival as obtained by ECIB treatment alone. Imuran, even in small non-toxic doses, showed complementary effects in prolonging skin allograft survival when combined with ECIB. (M.M.B.)

11999 ALLOGRAFT IMMUNITY PRODUCED WITH SKIN ISOGRAFTS FROM IMMUNOLOGICALLY TOLERANT MICE. Steinmuller, David (Inst. for Cancer Research, Philadelphia. Univ. of Pennsylvania, Philadelphia). Transplant. Proc.; 1: 593-6(Mar 1969).

From 2nd International Congress of the Transplantation Society, New York. See CONF-680922-(Pt.2).

Experiments are summarized that dealt with the possible immunizing ability of leukocytes or other adventitious cells trapped in tissue before transplantation. It was found that isografts from radiation chimeras immunized more frequently than those from mice made tolerant neonatally. This may be a result of the higher levels of leukocyte chimerism achieved with adult radiation-produced as opposed to neonatally produced tolerance. Experiments were performed on skin isografts in mice. It was found that immunizing ability was related to the number of leukocytes in an isograft. Grafts from an inflamed area were more likely to produce immunity than those from normal skin. Immunizing ability was related to the degree of leukocyte chimerism of the donors, and isografts from tolerant mice that were not leukocyte chimeras did not immunize. When tolerant mice were made leukopenic by whole-body x irradiation (900R), their ability to provide imminizing grafts was reduced 56%. These data establish a strong correlation between the presence of allogenic leukocytes in tolerant mice and the ability to produce isografts that produce specific allograft immunity. (M.M.B.)

12000 THYMUS: AN ESSENTIAL FACTOR IN LYMPHOID REPOPULATION. Stutman, O.; Yunis, E. J.; Good, R. A. (Univ. of Minnesota, Minneapolis). Transplant. Proc.; 1: 614-15(Mar 1969).

From 2nd International Congress of the Transplantation Society, New York. See CONF-680922-(Pt.2).

Thymic function was investigated for repopulation of lymphoid organs in both neonatally thymectomized or adult thymectomized-irradiated C3Hf/Bi mice. The latter were thymectomized at 30 days and irradiated with 900 R at 45 days. Both groups of mice were restored with syngenic liver cells in association with either functional strain A non-lymphoid thymoma or thymus grafts from syngenic or allogenic A, C57Bl/1, and $(C3HxA)F_1$ donors. Embryonic liver was effective only in association with syngenic thymus grafts. When thymoma or thymus were grafted within diffusion chambers, some degree of repopulation occurred only in animals treated with adult bone marrow. The results indicated that stem cells in the embryonic liver require the presence of thymus stroma for development of the ability to express immunological competence. Cells in the newborn liver and other hemopoietic tissues have already received this thymic influence. (M.M.B.)

12001 INTERACTION OF THE CARBOHYDRATE-BINDING PROTEIN CONCANAVALIN A WITH NORMAL AND TRANSFORMED CELLS. Inbar, Michael; Sachs, Leo (Weizmann Inst. of Science, Rehovot, Israel). Proc. Nat. Acad. Sci. U. S.; 63: 1418-25(Aug 1969).

It was shown that the carbohydrate-binding protein concanavalin A (ConA) can agglutinate leukemic cells and cells transformed by polyoma virus, simian virus 40, chemical carcinogens, and x irradiation. This protein did not agglutinate normal cells under the same conditions. The agglutination was reversed by competition with α-methyl-D-glucopyranoside (α-MG), a carbohydrate that strongly binds to ConA, but not by the carbohydrates α-methyl-L-fucopyranoside or N-acetylglucosamine, with no binding or weak binding to ConA. Destruction of the α-MG binding sites of the native protein by removal of bivalent metal ions abolished the agglutination produced by the native protein. The treatment of cells with trypsin resulted in the agglutination of normal cells by ConA and a decrease of agglutinability of transformed cells. When nonagglutinating untransformed 3T3 cells were infected with simian virus 40 and normal rat cells were infected with polyoma virus, the infected cells became agglutinable several days after virus infection. The percentage of cells agglutinated, about 50%, was much higher than the percentage of cells hereditarily transformed. The results indicate that the surface membrane of transformed cells contains sites that interact with the α-MG binding sites of ConA, that such sites can be found on the surface membrane of normal cells after treatment with trypsin, and that the change in the surface structure

from normal to transformed occurs in cells that are abortively transformed. (auth)

12002 BONE MARROW CONFERENCE. BONE MARROW TRANSPLANTATION AND CHEMICAL PROTECTION, ATLANTIC CITY, NEW JERSEY, APRIL 14, 1969. Congdon, C. C. (ed.). Exp. Hematol.; No. 19, 1-61(1969). (CONF-690434).

The proceedings of the conference on bone marrow, held in April 1969, are presented in this issue. Separate abstracts were prepared for seven of the 13 papers included in the conference. The other six papers discussed subjects related to the conference, but were not within the scope of NSA. (E.R.B.)

For abstracts of individual papers see: 11956 and 12003–12008.

12003 NONSPECIFIC RESPONSE TO ANTIGEN IN BONE MARROW CELLS. Talmage, David W.; Radovich, Jevrosima; Hemmingsen, Helen (Univ. of Colorado, Denver). Exp. Hematol.; No. 19, 3(1969).

From Bone Marrow Conference, Atlantic City, N. J. See CONF-690434.

Bone marrow cells are known to enhance the immune response of x-irradiated mice reconstituted with thymus of immune spleen. Experiments using x-irradiated intermediate host mice indicated that the response of bone marrow cells to antigen is nonspecific. Such cells multiplied in the absence of antigen, but were blocked nonspecifically by another antigen. (M.M.B.)

12004 PERSISTENCE OF PREIRRADIATION IMMUNITY TO HYMENOLEPIS NANA IN SYNGENEIC CHIMERAS: INFLUENCE OF RADIATION DOSE. Cearley, J. E.; Neas, B. R.; Coleman, R. L.; Friedberg, W. (Federal Aviation Administration, Oklahoma City. Univ. of Oklahoma, Oklahoma City). Exp. Hematol.; No. 19, 10-11(1969).

From Bone Marrow Conference, Atlantic City, N. J. See CONF-690434.

Mice preimmunized to Hymenolepis nana by infection were exposed to doses of x radiation of from 700R to 1450R. Animals were reconstituted with syngenic marrow from nonimmune donors. Each mouse, including nonirradiated or nonimmunized controls, was challenged with H. nana eggs 21 or 22 days after irradiation. At the lower doses, resistance persisted in immunized mice, but after doses of 1350R and 1450R many of the preimmunized animals became reinfected when challenged. (M.M.B.)

12005 ACTIVATION OF RESIDUAL COLONY-FORMING UNITS IN SUPRALETHALLY IRRADIATED MICE POSTTREATED WITH MARROW XENOGRAFTS AND RABBIT ANTIMOUSE THYMUS GLOBULIN. Delmonte, L.; Nora, A. H.; Fernbach, D. J. (Baylor Univ., Houston, Tex.). Exp. Hematol.; No. 19, 15-20 (1969).

From Bone Marrow Conference, Atlantic City, N. J. See CONF-690434.

Rat marrow cells are known to grow in the spleens of supralethally irradiated host mice. However, attempts to grow dog or baboon marrow cells in such mice failed although these cells did cause host derived endogenous colony-forming units to develop (endocolonization) in some of the host spleens. In an attempt to reduce the host's competence for xenograft rejection, supralethally irradiated (800 rad whole-body x-ray) mice were treated with normal rabbit globulin (NRG) or rabbit antimouse thymus globulin (RAMTG). NRG stimulated 3% endocolonization and RAMTG stimulated 25% in the spleens of irradiated mice. Macroscopically visible endocolonization did not occur in irradiated mice not treated with rabbit globulin. When rat bone marrow was injected into the irradiated mice it seeded equally well in the spleens of mice whether treated or not treated with rabbit globulin. Baboon and dog marrow both failed to grow in the spleens of any of the animals, however, both stimulated endocolonization in RAMTG-treated animals. The amount of endocolonization in the presence of baboon xenografts did not appear to be cell dose-dependent. The incidence of endocolonization was as great in irradiated hosts receiving lysed baboon cells (58%) as in those receiving intact baboon cells (50%). Preincubation of the baboon marrow with irradiated mouse marrow or rabbit antibaboon-lymphocyte serum reduced the incidence of endocolonization in RAMTG-treated hosts to less than additive levels and pretreatment with mouse marrow almost abolished it. (M.M.B.)

12006 EFFECT OF SUPPRESSION OF ERYTHROPOIESIS ON COLONY-FORMING UNITS OF MICE. Preisler, Harvey D.; Henderson, Edward S. (National Cancer Inst., Bethesda, Md.). Exp. Hematol.; No. 19, 20-2(1969).

From Bone Marrow Conference, Atlantic City, N. J. See CONF-690434.

Erythropoiesis was suppressed in mice either by injection of irradiated (1000R) or unirradiated packed red blood cells or by hypobaric conditioning. All methods also resulted in a significant increase in the number of femoral colony-forming units. Since neither transfusion of irradiated blood nor hypobaric conditioning could introduce stem cells into the mice, it is suggested that the cells responsible for colony formation must remain in cycle during erythropoietic suppression. The cells that would normally differentiate into erythrocytes would remain colony-forming units. (M.M.B.)

12007 RAPID INHIBITORY EFFECT OF IMMUNOSUPPRESSANTS IN GUINEA PIG. Maguire, Henry C. Jr. (Hahnemann Medical Coll. and Hospital, Philadelphia). Exp. Hematol.; No. 19, 27-9(1969).

From Bone Marrow Conference, Atlantic City, N. J. See CONF-690434.

Methotrexate and cyclophosphamide, but not whole-body x irradiation (400R), suppress the adjuvant step-up of delayed hypersensitivity. Because this adjuvant phenomenon is rapid, the results of prospective immunosuppression can be assayed in 3 days. The amounts of drug required to produce a positive result are considerably less than that ordinarily required to suppress adjuvant-induced hypersensitivity in the guinea pig. (auth)

12008 RADIATION EFFECTS ON DEXTRAN-INDUCED HYPERSENSITIVITY ASSESSED BY MOUSE PAW SWELLING. Uyeki, Edwin M. (Univ. of Kansas, Kansas City). Exp. Hematol.; No. 19, 37-9(1969).

From Bone Marrow Conference, Atlantic City, N. J. See CONF-690434.

A quantitative assessment was made of the dermal allergic reactions arising from prior subscapular injections of dextran, that induced swelling in mouse paws given subplantar injections. Whole-body γ irradiation reduced the 24 hr allergic response in all but one injection scheme. Radiation was not as effective in inhibiting the early (4 hr) response. In some schemes, radiation also suppressed the toxic swelling due to dextran itself. (M.M.B.)

12009 DISRUPTION OF SYNGENIC SKIN TRANSPLANTS AS A METHOD FOR DETERMINING CHIMERISM OF IMMUNOCOMPETENT CELLS IN F_1 HYBRIDS. Shevelev, A. S.; Semenkov, V. F. Dokl. Akad. Nauk SSSR; 187: 1408-11(21 Aug 1969). (In Russian).

A method was developed for the study of parent immunocompetent cells in the organism of F_1 hybrids under conditions that foster the transplant versus host reaction. It involves the grafting of syngenic skin after the introduction of F_1 parent spleen cells into hybrid mice, assuming thereby that the presence of immunocompetent cells that are able to react against the hybrid may interfere with the transplanted skin. The experiments were carried out with mice, exposing the hybrids to sublethal doses of 400 R x radiation, thus providing conditions for the proliferation of the parent cells. The results indicated that the presence of immunocompetent parent cells disrupted the syngenic skin graft tissues. This disruption of the syngenic and parent skin may be used as an indicator of the presence of live immunocompetent cells in the body of the recipient, able to react against the antigens. (TTT)

12010 IMMUNIZATION EXPERIMENTS WITH IRRADIATED LARVAE OF SYNGAMUS TRACHEA IN CHICKENS. Varga, I. (Univ. of Veterinary Sciences, Budapest). pp 1-11 of Isotopes and Radiation in Parasitology. Vienna; International Atomic Energy Agency (1968).

From Meeting on the Use of Isotopes and Radiation in Study and Control of Parasitic Diseases, Vienna, Austria. See STI/PUB-181; CONF-670738.

Among parasitic nematodes experimentally treated so far by irradiation, Syngamus trachea appears to be one of the most sensitive species. To attain equivalent biological effects higher doses of gamma radiation are required compared with x-ray irradiation under the conditions described. Doses of 5 to 8 kR gamma radiation were given. Preliminary trials were made with chickens one to three weeks old. The immunogen effect of irradiated larvae manifested itself in a reduced number (0 to 28%) of challenge worms compared with those of controls. While 24% of the immunized birds harbored worm pairs in smaller numbers, no worms could be detected at all in 76% of the birds. A more effective immunity resulted in groups of birds treated twice. Keeping in view the exigencies under field conditions, investigations on day-old chickens were conducted. As with pheasants and turkeys, though to a somewhat lesser degree, these can also be immunized. The immunity proved effective following heavy challenge infestations which caused the death of most of the controls. Development of immunity can be demonstrated as early as the sixth day following treatment; it attains a satisfactory degree on the tenth to twelfth day, and continues on into an age resistance. To ascertain whether a single immunization of young chickens, when treated before their

first feeding, was likely to protect them against natural infestation, attempts were also made to treat day-old chickens under farming conditions. Though exact investigations in this line present various difficulties with regard to the sometimes sporadic occurrence of syngamosis, yet results of the majority of the trials appear encouraging. Nevertheless, opinion as to the possibility of active immunization against the disease proving to be a valuable method of control requires further experimental work. (auth)

12011 DEVELOPMENT OF AN X-IRRADIATED VACCINE FOR ANCYLOSTOMIASIS. CURRENT PROGRESS. Miller, T. A. (Univ. of Glasgow). pp 13-15 of Isotopes and Radiation in Parasitology. Vienna; International Atomic Energy Agency (1968).

From Meeting on the Use of Isotopes and Radiation in Study and Control of Parasitic Diseases, Vienna, Austria. See STI/PUB-181; CONF-670738.

An effective vaccine against the dog hookworm, Ancylostoma caninum, is described. It consists of larvae, attenuated by exposure to x rays and shows the following properties: the immune response to irradiated larvae is greater than to normal larvae; immunity persists at an undiminished level for at least eight months (vaccination performed during the first three months of life); single vaccination gives good protection but two doses of vaccine given one month apart to pups three to four months old is more effective; vaccination is successful even when the first dose is given as early as 72 hours after birth. Double vaccination commencing at this time protects eight-week-old pups against potentially lethal challenge; prenatal infection of pups can be largely prevented by vaccination of bitches as early as possible in their lives (i.e., when bitches intended for breeding are themselves pups). The significance of the results for the preparation of a similar vaccine against human hookworms is discussed. (auth)

12012 IMMUNE RESPONSE OF YOUNG ANIMALS TO INFECTION WITH X-IRRADIATED AND NORMAL NEMATODE LARVAE. Urquhart, G. M. (Univ. of Glasgow). pp 35-41 of Isotopes and Radiation in Parasitology. Vienna; International Atomic Energy Agency (1968).

From Meeting on the Use of Isotopes and Radiation in Study and Control of Parasitic Diseases, Vienna, Austria. See STI/PUB-181; CONF-670738.

Two problems associated with the vaccination of young animals are: the difficulty of producing a degree of useful immunity before the host is subjected to a pathogenic level of infection; the possibility that young animals may be incapable of developing a good immune response or that exposure to infection or vaccination in early life may affect the subsequent immune response in adult life. These two topics are reviewed in the light of field and experimental evidence in farm animals. Finally, some recent experimental results on immunological unresponsiveness in the young rat to Nippostrongylus brasiliensis infection are presented and its implications discussed. (auth)

12013 RESISTANCE PRODUCED IN RATS AND MICE BY EXPOSURE TO IRRADIATED PLASMODIUM BERGHEI. Welide, B. T.; Sadun, E. H. (Walter Reed Army Inst. of Research, Washington, D. C.). pp 59-73 of Isotopes and Radiation in Parasitology. Vienna; International Atomic Energy Agency (1968).

From Meeting on the Use of Isotopes and Radiation in Study and Control of Parasitic Diseases, Vienna, Austria. See STI/PUB-181; CONF-670738.

Rats infected with P. berghei parasitized erythrocytes exposed to doses up to and including 16,000 R developed progressive parasitemias with obvious parasite multiplication and reinvasion of RBC's. Some rats receiving parasitized RBC's irradiated at levels of 17,000 and 18,000 R did not develop progressive infections. Infections were aborted by exposure to irradiation at 19,000 R or higher. Inoculation with parasitized blood exposed to 20,000 R stimulated a resistance to a challenge infection with nonirradiated parasites. The peak parasitemias reached in the immunized animals were significantly lower than those of the nonimmunized controls and reduction in parasitemias began much earlier. The degree of acquired resistance induced by inoculation with irradiated parasites was influenced by the number of immunizing exposures before the challenging infection. The acquired resistance induced by irradiated infected RBC's could be detected also in a more susceptible animal, such as the mouse. Twice-weekly inoculations of irradiated parasitized cells given 3, 5, and 10 times considerably extended the mean survival time after challenge; a significant number of mice survived otherwise lethal infections. In both rats and mice the degree of acquired immunity was directly proportional to the number of immunizing doses. Similar results were obtained when immunizations occurred at weekly intervals, or when given twice weekly. Likewise, no significant differences were detected when the challenge took place one or two weeks after the last immunizing dose. (auth)

12014 IMMUNE MECHANISMS IN MICE IMMUNIZED WITH IRRADIATED PLASMODIUM BERGHEI. Sadun, E. H. (Walter Reed Army Inst. of Research, Washington, D. C.). pp 75 of Isotopes and Radiation in Parasitology. Vienna; International Atomic Energy Agency (1968).

From Meeting on the Use of Isotopes and Radiation in Study and Control of Parasitic Diseases, Vienna, Austria. See STI/PUB-181; CONF-670738.

Acquired resistance to P. berghei has been observed in mice inoculated with irradiated parasites. The studies described below were done to elucidate some of the cellular and humoral mechanisms involved. Mice were immunized with five inoculations of irradiated P. berghei and challenged with nonirradiated parasites one week after the last immunization. The parasitemias of control animals rose rapidly, whereas parasitemias of immunized mice progressed at a much slower rate. On the day of challenge a significant increase in gamma globulins was noted in the immunized mice. Serum collected at this time contained protective antibodies as determined by passive transfer tests. Since parasitemias persisted in the challenged mice it seemed possible that such parasites represent variant or derived strain(s) relatively unsusceptible to cellular and humoral factors of acquired immunity. To compare antiserum susceptibility of parasites from control mice (stock strain parasites) with that of parasites from experimental mice (suspected variant strain parasites), subinoculations of parasites were made from both groups and parasites in recipient mice were then exposed to mouse antiserum. Antiserum collected on the day of challenge showed a relatively marked effect against the parasites of the stock strain but was relatively ineffective against parasites of the derived or variant strain. Rat antiserum from other sources showed similar differences in effectiveness against parasites of these two strains, providing further evidence for immunological differences in stock and derived strains of parasites. Mean-spleen weights of immunized mice were double the weights of the controls. (auth)

12015 IMMUNOLOGICAL STUDIES ON FASCIOLA HEPATICA. CLINICAL AND IMMUNOLOGICAL RESPONSE IN MICE TO INFECTION WITH IRRADIATED AND NORMAL FLUKE CYSTS. Sokolic, A. (Inst. for the Application of Nuclear Energy in Agriculture, Veterinary Medicine, and Forestry, Zemun, Yugoslavia). pp 93-103 of Isotopes and Radiation in Parasitology. Vienna; International Atomic Energy Agency (1968).

From Meeting on the Use of Isotopes and Radiation in Study and Control of Parasitic Diseases, Vienna, Austria. See STI/PUB-181; CONF-670738.

Clinical and immunological response in mice to infection with irradiated and normal fluke cysts is reviewed critically. Preliminary results on the clinical picture, haemagglutinating and complement-fixing antibody response as well as to the effect on miracidia of sera of mice infected with normal and irradiated metacercariae of F. hepatica are reported. Future lines of immunological studies on liver fluke are also discussed. The results obtained are as follows: the clinical picture was characterized by a marked loss in body weight, in the range of 23 to 30%, two weeks after infection in mice dosed with five normal, or with 20 or 100 irradiated cysts. An almost complete regain in body weight was found six weeks following the infection, except in mice dosed with 5 normal cysts. These still had a loss of 22%. The number of red cells decreased from an average of 7.7 millions/ml to 4.0, 4.1 and 3.7 millions/ml, respectively, three to four weeks after the above-mentioned infections. However, variations in the number of white cells, from 3400 to 19,900/ml, compared with 9300/ml in controls, were observed. Lymphocytosis, which was established, reached its peak three weeks after the second dose of 20 or 100 irradiated cysts. Basophil leukocytes were not noted; serologically, no haemagglutinating antibodies were found in any group of experimental mice. Complement-fixing antibodies, when stimulated by using infection with either normal or irradiated cysts, disappeared from the blood four weeks after infection, with only one exception related to the 100-cyst dose. A repeated infection of the groups of mice, four weeks later, with 20, 50 and 100 irradiated cysts, resulted in increased titers of complement-fixing antibodies. The titer of 160, expressed as a reciprocal of the dilution, was established, irrespective of the above doses, four weeks following the second infection. Longer time intervals between infection and other variables have not been explored as yet; the significance of the fluke infections in mice, by using the miracidial in vitro test, is in progress and the result of this investigation will be presented later. (auth)

12016 ON THE POSSIBILITY OF CREATION OF ACTIVE IMMUNITY WITH ENTERAL VACCINATION OF THE IRRADIATED BODY. Nikolaeva, L. A. (Gamaleia Inst. of Epidemiology and Microbiology, Moscow). Byull. Eksp. Biol. Med.; 68: No. 9, 78-81(Sep 1969). (In Russian).

Study of an immune process in mice from enteral typhoid vaccination is reported. It was shown that under definite conditions active immunity can be created in the body by enteral vaccination. This immunity is equal to the immunity in nonirradiated animals. (auth)

12017 INFLUENCE OF X IRRADIATION AND THE MILK AGENT ON GROWTH OF TRANSPLANTED MOUSE MAMMARY TUMORS. Prehn, Richmond T. (Univ. of Pennsylvania, Philadelphia). J. Nat. Cancer Inst.; 43: 1215-20(Dec 1969).

Prior sublethal x irradiation of recipient syngeneic mice regularly increased the growth of grafts of virus-induced mammary tumors when, and only when, the recipient animals lacked the mammary-tumor milk agent. Conversely, prior x irradiation actually inhibited the growth of subsequent tumor grafts when the animals harbored this virus. These results imply that the mammary tumors were antigenic in syngeneic mice free of the milk agent. Direct attempts to demonstrate antigenicity by immunization suggested that the antigenicity was relatively weak. Thus comparative growth of tumor implants in x-rayed and normal recipients may provide a simple and relatively sensitive method of testing for transplantation antigenicity. (auth)

12018 RADIOIMMUNOASSAY OF PANCREOZYMIN CHOLECYSTOKININ IN HUMAN SERUM. Young, J. D. (St. Vincent's Hospital, Sydney); Lazarus, L.; Chisholm, D. J.; Atkinson, F. F. V. J. Nucl. Med.; 10: 743-5(Dec 1969).

It is generally accepted that pancreozymin (PZ) and cholecystokinin (CCK) are one hormone. The effects of PZ-CCK on the exocrine function of the pancreas and gall bladder are well established, but recent investigations have suggested that PZ-CCK may also have an action on the endocrine function of the pancreas. Studies of the role played by PZ-CCK in the control of insulin secretion in the human have been hampered by the lack of a suitable technique for the measurement of PZ-CCK in human serum. A radioimmunoassay system for the measurement of PZ-CCK using ^{131}I-labeled PZ-CCK rabbit antiserum to porcine PZ-CCK, and an ion-exchange resin to separate the free labeled hormone from that bound by the antibody is described. This radioimmunoassay is suitable for measuring PZ-CCK in peripheral human serum. Preliminary physiological studies showed that PZ-CCK is released after fatty meals, protein meals, and large oral glucose loads, and might therefore contribute to insulin release in these situations. Detectable levels are not recorded after 50 gm of glucose. (auth)

12019 RADIOIMMUNOASSAY OF GASTRIN IN HUMAN SERUM USING ANTISERUM AGAINST PENTAGASTRIN. Young, J. D.; Byrnes, D. J.; Chisholm, D. J.; Griffiths, F. B.; Lazarus, L. (St. Vincent's Hospital, Sydney). J. Nucl. Med.; 10: 746-8 (Dec 1969).

Evidence is presented that antiserum prepared against the synthetic gastrin-like pentapeptide, Pentagastrin, may be used to set up a radioimmunoassay for gastrin in human serum. Although cross reactivity with pancreozymin has been shown and must lead to cautious interpretation of results, it appears that interference with gastrin estimation is only likely when there is a strong stimulus to pancreozymin release or where there is a possibility of multiple hormonal secretion by a gastrin-producing tumor. (auth)

12020 EFFECTOR MECHANISMS OF SKIN HOMOGRAFT REJECTION IN AGAMMAGLOBULINEMIC CHICKENS. Perey, Daniel Y. E.; Dupuy, Jean-Marie; Good, Robert A. (Variety Club Heart Hospital, Minneapolis. Univ. of Minnesota, Minneapolis). Transplantation; 9: 8-17(Jan 1970).

Normal chickens and agammaglobulinemic young chickens were sensitized to wattle homografts. They were then x irradiated and, three to six days later, they were heparinized, exsanguinated, and plasma-harvested. When small volumes of this plasma were injected i.p. into normal chicks, the recipients became specifically sensitized to the wattle homografts. The effectiveness of plasma from young agammaglobulinemic chickens, which are immunologically deficient except for thymus-related activities, suggests that thymus-related lymphocytes produce immunologically specific mediators which accumulate in the circulation after x irradiation and differ from conventional immunoglobulins. Adoptive transfer of wattle homograft immunity could not be demonstrated with injections of plasma from sensitized nonirradiated or nonsensitized irradiated chickens. If confirmed, this theory implies that subcellular, immunologically specific mediators of so-called cell-mediated immunities can be released into the circulation under stress such as irradiation. These mediators, which are normally cell-bound, are released following lysis of cells which produce them and/or destruction of receptor sites on cells which normally remove them from the circulation. (auth)

12021 GROWTH HORMONE IMMUNOLOGICAL AND BIOLOGICAL ASSAYS IN PITUITARY OF RAT UNDER DIFFERENT EXPERIMENTAL CONDITIONS. Mueller, E. E.; Miedico, D.; Giustina, G.; Pecile, A. (Univ. of Pavia, Italy. Univ. of Milan). Experientia; 25: 1146-7(15 Nov 1969).

For radioimmunoassay procedures, rat growth hormone was used for standards and preparation of antibody. The hormone was iodinated with ^{125}I and separation of bound from free hormone was obtained by precipitation of antibody bound hormone with rabbit anti-guinea pig gamma globulins. For bioassay of growth hormone, the tibia test was used. Pituitary extracts equivalent to 0.5 mg of pituitary per assay rat were administered each day for 4 days to hypophysectomized assay animals. On the fifth day, the width of the epiphyseal cartilage was measured. During conditions of hypoglycemia, exposure to cold, and fasting, no significant change in pituitary growth hormone was demonstrated by radioimmunoassay; however, a significant decrease in growth hormone was observed by the method of bioassay. (H.L.W.)

Ecology

Refer also to abstracts 11455, 11691, 11901, 11903, 12060–12063, and 12211.

12022 (A-AC-82/G/L-1239) ^{90}Sr IN HUMAN BONE (DENMARK, 1964–1967). Levi, H.; Lindemann, J.; Fenger, K. (Copenhagen Univ. (Denmark)). 6p. Dep. CFSTI (U. S. Sales Only).

The results of continuing investigation of ^{90}Sr in human bone are listed in tabular form. One table gives the ^{90}Sr content of columnae of human fetuses, still-births, and children between 1 and 30 days old. Another table lists the ^{90}Sr content of columnae of children between 1 month and 12 years of age. Both tables are arranged according to the date of abortion or death. The results show that ^{90}Sr content of bone of humans under 1 month old declined during the period January 1965 through October 1967 from values above 2 S. U. to below 1 S. U. The S. U.-values of older children are still higher than those of fetuses and infants, and the scatter is larger, as observed earlier. The standard error of the S. U.-values due to counting statistics alone is 0.03, while the total reproducibility of the analyses is estimated to be within 10 per cent. (C.O.)

12023 (AEC-tr-7128) USSR REPORTS ON NATURAL AND FALLOUT RADIOACTIVITY. Translation of Russian articles. 286p. Dep. CFSTI.

Separate abstracts were prepared for the 24 papers appearing in this translation. Abstracts for the five papers appearing under report number A-AC-82/G/L-1243 were included in Vol. 23 of NSA as abstracts 24499, 24574, 24575, 24576, and 24604. These five abstracts, along with the lead abstract for the report (24573), were prepared from the papers in their original language. The same is true of the five papers appearing under report number A-AC-82/G/L-1254. The abstracts of these five papers (in their original language) also appeared in Vol. 23 of NSA as abstracts 24578, 24579, 24580, 24581, and 24711. The lead abstract for these papers was 24577. (E.R.B.)

For abstracts of individual papers see: 11690, 11691, 11699–11701, 11709, 11901–11903, 12024–12033, and 12060–12064.

12024 (AEC-tr-7128, pp 2-5) THE CONCENTRATION FACTOR OF ^{90}Sr IN PLANKTON IN VARIOUS KINDS OF RESERVOIRS. Kalninya, Z. K.; Polikarpov, G. G. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). Translated from report A-AC-82/G/L-1243.

An abstract of this paper from the original language has appeared previously in NSA as abstract number 24604. (H.L.W.)

12025 (AEC-tr-7128, pp 6-13) ^{90}Sr IN THE DANUBE RIVER AND THE ADJACENT INTERNATIONAL ZONE OF THE BLACK SEA (A RADIOECOLOGICAL STUDY). Polikarpov, G. G.; Timoshchuk, V. I.; Sokolova, I. A.; Parchevskii, V. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). Translated from report A-AC-82/G/L-1243.

An abstract of this paper from the original language appeared previously in NSA as abstract number 24574. (E.R.B.)

12026 (AEC-tr-7128, pp 14-29) THE ROLE OF SOME MARINE ORGANISMS IN THE MIGRATION OF MANGANESE, COPPER, AND ZINC IN THE SEA OF AZOV. Rozhanskaya, L. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). Translated from report A-AC-82/G/L-1243.

An abstract of this paper from the original language has appeared previously in NSA as abstract number 24575. (H.L.W.)

12027 (AEC-tr-7128, pp 30-8) CONCENTRATION FACTORS OF MANGANESE, COPPER, AND ZINC IN SOME AQUATIC ORGANISMS IN THE SEA OF AZOV. Rozhanskaya, L. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). Translated from report A-AC-82/G/L-1243.

An abstract of this paper from the original language has appeared previously in NSA as abstract number 24576. (H.L.W.)

12028 (AEC-tr-7128, pp 51-6) ^{90}Sr IN CERTAIN ORGANISMS IN THE RED SEA AND THE GULF OF MEXICO. Parchevskii, V. P.; Sokolova, I. A.; Polikarpov, G. G.; Zaitsev, Y. A.; Bachurin, A. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). Translated from report A-AC-82/G/L-1254.

The distribution of ^{90}Sr in algae, corals, echinoderms, and molluscs of the Red Sea and the Gulf of Mexico was studied. The extent of strontium and yttrium recovery was established during the radiochemical determination of ^{90}Sr in marine algae and water. Comparisons of the ^{90}Sr concentration in related types of sargassum and madrepore corals showed that the content of this radionuclide was 1.5 to 2 times greater in related organisms in the Gulf of Mexico than in the Red Sea. The highest concentrations of ^{90}Sr were recorded in the shells of molluscs and in corals. (H.L.W.)

12029 (AEC-tr-7128, pp 57-8) STRONTIUM CONTENT OF PLANKTON IN THE PACIFIC AND ATLANTIC OCEANS. Barinov, G. V.; Romanov, V. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). Translated from report A-AC-82/G/L-1254.

Strontium-90 concentrations were measured in the water of the Atlantic and Pacific Oceans and concentration factors in plankton were calculated. Methods of collecting plankton and calculation of concentration factors are described. Results showed that the strontium content of plankton taken from various regions of the Atlantic and Pacific Oceans was very small. The concentration factors were virtually identical and varied within a range of 1 to 3 units. It appears that strontium is generally concentrated to a very small extent by sea and ocean plankton and that plankton plays a negligible role in the vertical transport of both stable and radioactive strontium from the surface layer of the ocean in which the main plankton biomass is distributed. This conclusion relates primarily to the subtropical and tropical regions of the Pacific where the plankton biomasses are small. (H.L.W.)

12030 (AEC-tr-7128, pp 59-61) UPTAKE BY ALGAE AND PLANKTON OF NATURAL AND ARTIFICIAL RADIONUCLIDES IN THE OCEAN. Barinov, G. V.; Blinov, M. V.; Gritchenko, Z. G. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). Translated from report A-AC-82/G/L-1254.

The seaweed, Sargassum, was collected in the Caribbean, the Gulf of Mexico, and the Sargasso Sea and analyzed for ^{234}Th; the concentration factor was found to be 1,104. Green algae were also found to be concentrators of ^{234}Th with a concentration factor of $r \times 10^5$. The ability of green algae to accumulate ^{234}Th selectively was used to develop a method of determining the ^{234}Th content of sea and ocean surface waters. Zooplankton collected in the Mururoa Atoll region contained appreciable quantities of ^{95}Zr, ^{95}Nb, ^{103}Ru, ^{141}Ce, and ^{144}Ce. The role of zooplankton as biological indicators of the presence of artificial radionuclides in sea water was pointed out. (H.L.W.)

12031 (AEC-tr-7128, pp 143-51) QUANTITATIVE ESTIMATION OF THE ^{90}Sr INTAKE BY PLANTS FROM THE SOIL AND ITS ACCUMULATION IN CROPS. Arkhipov, N. P.; Egorov, A. V.; Klechkovskii, V. M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). Translation of report A-AC-82/G/L-1290.

For studies on ^{90}Sr uptake by plants, 112 experimental plots were subdivided into eight series of 14 plots each; properties of the soil in each series were approximately identical. Strontium-90 was added to the plots in amounts varying from one to 110 microcuries per sq m. The following plants were cultivated for seven years in the experimental plots: winter rye, spring wheat oats, vetch, lucerne, clover, potatoes, and corn. Tables are presented to show correlation coefficients between ^{90}Sr content of the soil and of the crop harvest. Results showed that there was a close correlation between the ^{90}Sr content of the soil and that of the crop plants. (H.L.W.)

12032 (AEC-tr-7128, pp 180-93) ^{210}Pb AND ^{210}Po IN ARCTIC REGIONS OF THE NORTHEAST. Litver, B. Ya.; Ramzaev, P. V.; Moiseev, A. A.; Troitskaya, M. N.; Krisyuk, E. M.; Lisachenko, E. P.; Nizhnikov, A. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). Translation of report A-AC-82/G/L-1293.

The lichen-reindeer-man food chain has been found to exert a cumulative action on radioisotopes. In this connection, studies were carried out to determine the ^{210}Pb content of biosamples from subarctic region, collected both before and after the atomic bomb tests; in addition, the ^{226}Ra and ^{228}Th content of lichens and reindeer bones was also determined. The specimens were collected in the Murmansk and Nenets regions; the bones of native inhabitants of arctic regions were obtained from the Leningrad museum. The results indicated that the ^{210}Pb content in the Northern food chain before (1900 to 1945) and after (1958, 1965/66) the atomic tests did not differ substantially. The ^{210}Pb data of reindeer bones also revealed that the concentration of this element does not change with time. The differences observed in humans may be attributed to contamination. It was concluded that the ^{210}Pb content is probably due to the natural decay of ^{226}Ra; the effect of atomic testing is small. The internal skeletal dose of reindeer polonium was calculated to amount to 0.8 rad/year up to 1900, 1 rad/year for the 1900 to 1945 and 1945 to 1966 periods. The data also indicate that ^{210}Pb is cumulated in reindeer by a factor of 4 and ^{226}Ra by a factor of 8; these values are much lower than those reported for man. (TTT)

12033 (AEC-tr-7128, pp 194-207) BEHAVIOUR OF URANIUM IN THE BIOLOGIC CHAIN. Prister, B. S. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). Translation of report A-AC-82/G/L-1298.

Field experiments on the accumulation of uranium in basic crops were carried out for three years on a large tract of land. Crops included grains, legumes, root crops, and vegetables. Measurements of the uranium content of the soil were made by extracting uranium with nitric solutions. A formula is presented for determining the coefficient of accumulation, or relative capacity of plants to accumulate uranium. Values for these coefficients are tabulated for grains, legumes, root plants, and vegetables. Data on accumulation of uranium in tissues of chickens and swine are tabulated. Studies on concentration of uranium in dairy products showed that the content of butter and cheese was eight times as great as that of milk. Data on uranium content of the human diet showed that more than half the uranium reached man through products of vegetable origin. Food products of animal origin contributed 28% of uranium to man. (H.L.W.)

12034 (BMI-171-23) BIOENVIRONMENTAL AND RADIOLOGICAL-SAFETY FEASIBILITY STUDIES: ATLANTIC-PACIFIC INTEROCEANIC CANAL. DARIEN FISH DIETARY. Duke, James A.; Rudolph, Ann W. (comps.) (Battelle Memorial Inst., Columbus, Ohio). June 13, 1969. Contract AT(26-1)-171. 150p. Dep. CFSTI.

A preliminary discussion is presented concerning kinds of freshwater and marine fish used as food by man, bait used for fishing, methods of fishing, and types of fish eaten at different seasons. The body burdens of ^{55}Fe in people who eat Alaskan marine fish were found to be several times higher than those of caribou-eating eskimos. A brief review of the literature on food habits of fish is given, and there is a discussion of the role of fish in food chains and mixing of faunas. The importance of sea grass (Thalassia sp.) as food for fish and invertebrates is discussed. An extensive list of freshwater and marine fish found or expected in Panama and adjacent Colombia with notes on their uses and feeding habits is presented. Both scientific and common names are included. A bibliography of approximately 150 references is appended. (H.L.W.)

12035 (BMI-171-25) BIOENVIRONMENTAL AND RADIOLOGICAL-SAFETY FEASIBILITY STUDIES: ATLANTIC-PACIFIC INTEROCEANIC CANAL. POSSIBLE EFFECTS OF A SEA-LEVEL CANAL ON THE MARINE ECOLOGY OF THE AMERICAN ISTHMIAN REGION: ABSTRACTS. Carroll, Thomas E.; Rudolph, Ann W. (comps.) (Battelle Memorial Inst., Columbus, Ohio). July 22, 1969. Contract AT(26-1)-171. 275p. Dep. CFSTI.

In support of a research program to study the "Possible Effects of a Sea-Level Canal on the Marine Ecology of the American Isthmian Region," a collection of 674 documents has been abstracted and indexed in depth. This volume of computer-printed indicative abstracts together with the companion volumes of coordinate index and thesaurus constitutes a portable information storage and retrieval system which may be used by the individual researcher independently of the computer facility. Some of the major topics included in this compilation are: geological history of the isthmian region, flora and fauna of the eastern tropical Pacific and western Caribbean, physical and chemical oceanography of the isthmian region, present and potential fisheries, marine biology and ecology, mathematical modeling, distribution of species, life history information, and population dynamics. Rapid and detailed access to the contents of this compilation are provided by the companion coordinate index and thesaurus. The use of the index and the thesaurus is discussed in the preface to these volumes. (auth)

12036 (BMI-171-123) A PRELIMINARY MATHEMATICAL MODEL FOR PREDICTING THE TRANSPORT OF RADIONUCLIDES IN THE MARINE ENVIRONMENT. Bloom, S. G.; Raines, G. E. (Battelle Memorial Inst., Columbus, Ohio). 20 Nov 1969. Contract AT(26-1)-171. 20p. Dep. CFSTI.

A mathematical model to describe the transport of radionuclides in the marine environment and their accumulation in marine organisms is derived. Expressions for the internal radiation dose to Standard Man following the consumption of sea foods are then derived on the basis of this model. These expressions give conservatively high estimates of the potential internal radiation dose, which can be compared with radiation-protection guides to determine the necessity, if any, of radiological safety measures. The model derivation starts with an instantaneous point-source solution to a partial differential equation that has been shown to be an adequate description of the physical dispersion process in the ocean. An expression for the radionuclide concentration in the ocean resulting from a fallout input is developed from this point-source solution. This expression indicates that vertical diffusion is the controlling mechanism for dispersion soon after the fallout deposition, and that convection controls dispersion later. From this observation, two simpler expressions are derived, one for early and one for later times. The simpler expressions for describing dispersion of a fallout input are used to define a mixing volume which then is considered to be the receptor of both the fallout and the terrestrial radionuclide inputs. The terrestrial input is due to direct ground water contamination and terrestrial fallout. From these concepts, an expression is derived for the radionuclide concentration in the mixing volume. This expression is then combined with a seawater-seafood-man food-chain model to arrive at expressions for the infinite internal radiation dose to man. (auth)

12037 (UCSD-10-P-20-52(Pt.2)(Vol.1)) RESEARCH ON THE MARINE FOOD CHAIN. PROGRESS REPORT, JULY 1968-JUNE 1969. PART II. MANUSCRIPT REPORTS OF WORK CONCLUDED. VOLUME 1. CHEMISTRY AND MICROBIOLOGY. Strickland, John D. H. (California Univ., La Jolla. Inst. of Marine Resources). Contract AT(11-1)-Gen-10. 271p. (IMR-69-9(Pt.2(Vol.1)). Dep. CFSTI.

Chemical investigations included determination of stable carbon isotopes in dissolved organic matter of the sea; micro-determination of uronic acids and related compounds in the marine environment; influence of temperature and solar radiation on vitamin B_{12}, thiamine, and biotin in seawater; ^{12}C: ^{12}C ratios in dissolved and particulate organic matter in the sea; ecology of plankton in relation to vitamins; and determination of ammonia in natural waters. Microbiological studies included nitrification by marine bacteria in low concentrations of substrate and oxygen; cultural characteristics of a pelagic marine ciliate; determination of microbial biomass in ocean profiles; observations on continuous culture of a planktonic phagotrophic protozoan; and observations on heterotrophic activity in the eastern tropical Pacific. (H.L.W.)

12038 TURNOVER AND CONCENTRATION OF RADIONUCLIDES IN FOOD CHAINS. Reichle, D. E.; Dunaway, P. B.; Nelson, D. J. Nucl. Safety; 11: 43-55(Jan-Feb 1970).

Proliferation of nuclear technology and concern for radioactivity in the biosphere demand more sophisticated evaluation of future nuclear installations and procedures. Adequate analyses of radionuclide dispersion in the environment will require more substantial bioenvironmental information than is presently available. Frequently information known for one ecological system (e.g., Arctic tundra) will not be applicable to other ecosystems (e.g., temperate or tropical forests). Only with sufficient ecological data can predictive models be developed that will enable assessment of the environmental consequences of radioactive contamination. A simple source-pathway-receptor model, analogous to the ecological food chain, requires pathway identification, data on assimilation by each link (organism) in the pathway, and determination of the biological turnover of each radionuclide. For acute releases of radioactivity to the environment, evaluation of these variables is needed to predict time-dependent concentrations of radioactivity in organisms. For chronic releases, concentration factors alone will often suffice. The biological concentration and turnover of radionuclides by animals are summarized in this paper. Data are presented for use in environmental models and correlation with species characteristics (e.g., body size) that allow estimation of absolute values for many different animal groups based on existing experimental data. (auth)

12039 BIOLOGICAL IMPLICATIONS OF A MARINE RELEASE OF ^{90}Sr. Vaughan, Burton E.; Strand, John A. (Naval Radiological Defense Lab., San Francisco). Health Phys.; 18: 25-41(Jan 1970).

For a situation represented by instantaneous release of ^{90}Sr-oxide in the ocean, we have devised a model of biotic radiocontamination which is based more realistically on known characteristics of coastal marine organisms. In the contamination model developed herein radioactivity concentration in soft tissues of migratory fish has been determined by (1) pool radioactivity using a modified Carter-Okubo diffusion model, (2) uptake and concentration kinetics, and (3) migratory interception as a function of pool size. Reasonably good validation of this approach was provided by information available from Operation Swordfish, and differences in the Operation Swordfish release and a hypothetical release of ^{90}Sr-oxide were examined. For 7.5×10^3 Ci of ^{90}Sr-oxide released, probable contamination of economically important pelagic fish would be accordingly less than that consequent on a water concentration maintained at 1 MPCC. Certain limitations as to generalizing this model are discussed in the report. The problems arising concern chiefly behavior of sedentary organisms, and biological uptake during very protracted release conditions. In these two cases present state-of-the-art does not permit adequate assessment of radiocontamination. (auth) (UK)

Genetics and Cytogenetics

Refer also to abstracts 11967, 11988, 11991, 11992, 11996, 12223, and 12229.

12040 (ORO-672, pp 157-63) EVALUATION OF THE EFFICIENCY AND EFFECTIVENESS OF DIFFERENT SEED MUTAGENIC TREATMENTS. Constantin, M. J.; Conger, B. V. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

Information concerning γ and fission neutron irradiation of seeds is summarized and briefly discussed. The data on mutation frequency were limited to cotton (studies of marker loci) and barley (chlorophyll deficient mutants). All indications were that the unmoderated fission neutrons were more effective than γ rays. Data from the studies are presented in tabular form. (C.O.)

12041 (ORO-672, pp 164-6) MUTATIONS IN QUANTITATIVELY INHERITED TRAITS. Constantin, M. J.; Conger, B. V. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

Results of experiments in progress to evaluate changes in quantitative traits induced by seed irradiation (γ rays and neutrons) and by ethyl methane sulfonate (EMS) are reported. Wheat, barley, and oats were used. Experiments advanced through the M_3 generation without specific selection. Seedling studies with one variety of wheat showed that early seedling height did not show changes attributable to mutagenic treatment. (C.O.)

12042 (ORO-672, pp 184-5) INDUCTION OF BUD SPORTS IN ORNAMENTAL PLANTS. Constantin, M. J.; Graham, E. T. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

The program initiated for the study of bud-sport induction by ionizing radiation is described. The following plants are to be studied: forsythia, pyracantha, rubus, weigela, and taxus. To date, only cuttings have been rooted. Either the mother plant or the cuttings were irradiated with γ rays or neutrons. (C.O.)

12043 (ORO-672, pp 186-8) COOPERATIVE IRRADIATIONS. Constantin, M. J. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

Results of the program offering services to public-service plant geneticists and breeders who felt a need for induced mutations in their materials are reported. Materials irradiated during 1968 with fission neutrons or ^{137}Cs or ^{60}Co γ radiation are listed. Data on the number of participants who sent material to be irradiated during the years from 1956 to 1968 are presented in graphic form. (C.O.)

12044 (ORO-2832-79, pp 2-11) STRUCTURE OF AND RADIATION EFFECTS ON CHROMOSOMES AND DNA. Cole, Arthur; Corry, Peter M.; Langley, Ruthann (Anderson (M. D.) Hospital and Tumor Inst., Houston, Tex.).

Studies on the mammalian metaphase chromosome structure indicated that the chromosome consists of 64 parallel DNA molecules that, because of association in the centromere region are carried as a unit in cell division. Studies on double-strand degradation and repair of DNA following 50 krad γ irradiation led to the following conclusions: the DNA of CHO Chinese hamster cells has the same molecular weight distribution (sucrose density gradient) as that of the B-14 cell line. The radiosensitivity for the different phases of the mitotic cycle is the same. The molecular weight distribution for the different phases of the mitotic cycle does not change and is the same as that for interphase cells. A double-strand repair process probably exists in mammalian cells. Other conclusions were that ionizing radiation, in addition to causing double and single strand scission and base damage of the DNA, may cause further damage to nucleoprotein and cause dissociation of protein from the DNA, and that DNA subunits of ~200 ×

10^6 Daltons molecular weight are linked together by protein to form higher molecular weight molecules. Data supporting these conclusions are presented in graphic form. (C.O.)

12045 DOES HYDROXYUREA INHIBIT CHROMOSOME REPAIR IN CULTURED HUMAN LYMPHOCYTES? Premfree, T.; Merz, T. (Johns Hopkins Univ., Baltimore). Nature (London); 224: 603-4(8 Nov 1969).

Hydroxyurea is known to be a powerful inhibitor of normal semiconservative DNA synthesis, and it was suggested that it may exert its effect at the level of the conversion of ribonucleotides to deoxyribonucleotides. On the other hand, hydroxyurea does not appear to prevent unscheduled DNA synthesis following irradiation; this is believed to represent repair synthesis, and leads to the question does chromosomal repair or rejoining occur during treatment with hydroxyurea. In the studies described cultures of human lymphocytes were treated with hydroxyurea or x rays (100 R/min), or both, starting 1 hr after initiation of the cultures Repair times (the time required for x-ray induced breaks to be altered so as not to be available for exchange with subsequently induced breaks) were measured. The results of such exchange were seen as dicentric chromosomes. Data are tabulated for the effect of varying concentrations of hydroxyurea on transformation and mitotic activity in human lymphocytes treated in the G_1 stage; also for the effect of hydroxyurea on chromosome aberration rates; and also for the effect of hydroxyurea on chromosome repair time. Frequencies of transformed cells in mitotic indexes were clearly reduced by 3 mM or higher concentrations of hydroxyurea present for 90 min. The aberration frequency at up to 4 mM was no different from the control rate. No dicentrics or other exchanges were observed with up to 4 mM hydroxyurea. Hydroxyurea at 2 mM in the combined study with X-rays did not induce chromosome breaks which could be run in the first post-treatment division. There was evidence, however, that high concentrations of hydroxyurea prevent cells entering the S stage and subsequently dividing. In order to test the effect of hydroxyurea on chromosome repair time it was necessary to ascertain the normal repair time, and for this purpose the cultured lymphocytes were irradiated with 300 R X-rays in two equal doses with varying time intervals. It appeared that breaks induced by the first 150 R were repaired by 90 min., so that they were no longer available to interact with the breaks induced by the second 150 R dose. The repair time, however, was longer than 60 min. When hydroxyurea (2 mM) was added to the medium during the 90 min interval between the 150 R doses the frequency of dicentrics rose to 26% (dose to that with a single 300 R irradiation). The data support the theory that hydroxyurea inhibits the repair of chromosome breaks, but does not itself induce chromosome breaks. (UK)

12046 RADIOSENSITIVITY AND AGING OF ALLIUM FISTULOSUM L. SEEDS. Nechitailo, G. S. (Inst. of General Genetics, Moscow). Radiobiologiya; 9: 774-6(1969). (In Russian).

Seeds of Allium fistulosum L., stored for various periods, were subjected to γ-irradiation with cesium-137 at a dose of 1000 R with a dose rate of 700 R/min. The dynamics of mutation of the cells and the spectrum of structural mutations of the chromosomes were determined on a population of seedlings that had reached 5 mm by 66 hrs from the beginning of germination. Old seeds, stored for 2 years, which had a higher level of natural mutation of the cells, were found to be more damaged by γ-irradiation. (tr-auth)

12047 INFLUENCE OF TEMPERATURE DURING GAMMA-IRRADIATION OF SEEDS ON THE AMOUNT OF CYTOGENETIC DAMAGE. Kuzin, A. M.; Runova, Yu. N.; Ladygina, V. G. (Inst. of Biological Physics, Pushchino-on-Oka, USSR). Radiobiologiya; 9: 720-3(1969). (In Russian).

The investigation indicated that in the irradiation of barley seeds, the radiation effect (level of chromosome aberrations in root meristem cells at the beginning of the first mitosis and development of seedlings) depends on the temperature during irradiation of the seeds. The presence of a temperature maximum was demonstrated. The dependence detected in turn is determined by the moisture content of the irradiated seeds. At 5.2% moisture content, the maximum lies at 40°C; at 11.6% moisture content it decreases to 20°C, while at 19.9% moisture content the temperature during irradiation has practically no influence on the radiation effect. The possible mechanisms of the observed effects are discussed in the work. (tr-auth)

12048 THE MUTAGENIC EFFECT OF ETHYL METHANE SULFONATE ON A NON-ACID-FAST STRAIN OF MYCOBACTERIUM PHLEI. Konicek, J.; Malek, I. (Inst. of Microbiology, Prague). Folia Microbiol. (Prague); 14: 194-200(1969).

The mutagenic effect of uv radiation and ethyl methane sulfonate (EMS) was compared by observing the induction of auxotrophic mutants, streptomycin (STM)-resistant mutants, and the induction of scotochromogenic and achromogenic mutants, the pigmentation changes being previously found useful as a genetic marker in mutation studies. The inactivation effect of EMS was examined to obtain data required for study of the mutagenic effect. The inactivation of cells of Mycobacterium phlei PN by EMS was very slow; 2-hr treatment with 0.2 M EMS at pH 6.6 resulted in about 80% survival, the inactivation then became faster, reaching values below 0.1% after 5-hr treatment. A total of 20 auxotrophic mutants induced by EMS was isolated. The mutants were usually isolated after using doses yielding high survival of the cells of the basic suspension. The auxotrophic mutants isolated required mostly amino acids, two mutants required purines, and three mutants required vitamins. The spectrum of auxotrophic mutants induced with EMS resembled more closely that obtained after uv treatment than that obtained when using nitrogen mustard. As compared with uv-radiation experiments, the EMS mutants were usually detected after treatment with doses yielding a higher survival of the cells. Three mutants requiring nicotinic acid, pyridoxine, and thiamine were obtained with EMS as compared to uv-treatment, after which no mutants requiring vitamins were detected. On the other hand, many more mutants requiring components of nucleic acids were obtained in the PN strain as a result of uv irradiation. Nine auxotrophic mutants representing six different phenotypes could be used in further genetic studies due to their low frequency of spontaneous reversions. Mutants with altered pigmentation were usually stable and may hence also be used in further genetic work. EMS increased the frequency of induced STM-resistant mutants by about 2.25 of an order of magnitude, the maximum phenotypic expression being reached after 72 hr incubation in a drug-free liquid medium. The maximum phenotypic expression was reached as early as 48-hr incubation in the same medium when uv radiation was used. (BBB)

12049 GENETIC AND ENVIRONMENTAL VARIABILITY IN SEGREGATING PIGEON PEA POPULATIONS. Abrams, Raul. pp 22-31 of Proceedings of the Caribbean Food Crops Society. Vol. VI. St. Augustine, Trinidad; Caribbean Food Crops Society (1968).

See CONF-680713.

Studies were conducted on heritability of the quantitative characters, flowering date, plant height, and seed weight in different populations of pigeon peas. Three varieties and a radiation derived line were used as parents in five crosses. Data were recorded for each plant in the F_2, F_3, and parental progenies. The data show that plant height is positively correlated with late flowering and negatively correlated with seed weight and number of seeds per pod. Seed weight showed a high heritability percentage, and number of seeds per pod showed the lowest heritability values. (H.L.W.)

12050 CHROMOSOME DAMAGE AFTER TREATMENT WITH CYSTEAMINE IN NONIRRADIATED AND IRRADIATED HUMAN LEUKOCYTES. Nasjleti, Carlos E.; Spencer, Herbert H. (Veterans Administration Hospital, Ann Arbor, Mich. Univ. of Michigan, Ann Arbor). J. Nucl. Med.; 10: 495-500 (Jul 1969).

The radioprotective effects of cysteamine (MEA) at various concentrations were tested in an in vitro system based on a comparative analyses of the frequency of chromosomal injuries in cultured human leukocytes. These cells were treated with MEA alone or in combination with x rays. MEA did not protect these cells against radiation in this system. On the contrary, in leukocytes treated with MEA alone, a high frequency of chromosomal aberrations resulted. MEA-treated cultures showed cytogenetic damage that included chromatid breaks, achromatic gaps, and constrictions of the erosion type. Increased number of polyploid cells was found in these cultures. After x irradiation of previously MEA-treated cultures, a striking number of dead cells appeared in addition to the chromosomal abnormalities. There appeared to be a summation of deleterious effects with the combined treatment. (auth)

12051 MUTAGENIC EFFECT OF SENSITIZED IRRADIATION OF BACTERIOPHAGE T4. Meistrich, M. L.; Shulman, R. G. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Mol. Biol.; 46: 157-67(28 Nov 1969).

The mutagenic behavior of thymine dimers has been studied using a sensitization technique to produce the dimers in the DNA of bacteriophage T4. Measurement of the rates of induction of r mutants and the classification of the rII mutants by reversion analysis has yielded the same results for both direct ultraviolet light and sensitization. These experiments indicate that thymine dimers can act as premutational lesions for mutants of both the transition and frameshift types. Furthermore, other lesions induced by direct ultraviolet light must be mutagenic. (auth)

12052 A NEW STRAIN OF ASPERGILLUS NIGER PRODUCING CITRIC ACID. Das, A.; Nandi, P. (Bose Inst., Calcutta). Experientia; 25: 1211(15 Nov 1969).

A strain of Aspergillus niger was treated with γ and uv radiation and nitrogen mustard. Fermentations were run and broth was harvested on the tenth day of incubation. Following each experiment 500 substrains were grown in fermentation medium to test for citric acid yielding capacity. A mutant derived from γ radiation was then subjected to uv radiation and fermentation studies revealed that the mutant produced 4.3 times as much citric acid as the parent strain. (H.L.W.)

12053 EFFECTS OF 2450 MHz MICROWAVES ON PROTEIN SYNTHESIS AND ON CHROMOSOMES IN CHINESE HAMSTERS. Janes, D. E.; Leach, W. M.; Mills, W. A.; Moore, R. T.; Shore, M. L. (Bureau of Radiological Health, Rockville, Md.). Non-ioniz. Radiat.; 1: 125-30(Dec 1969).

Male Chinese hamsters were investigated for the effects of whole-body microwave irradiation on the in vivo incorporation of ^{14}C-labeled phenylalanine into protein of liver and testis, and the chromosomes of mitotic bone marrow cells. Incorporation of labeled amino acid into protein was decreased in both liver and testis. Chromosome stickiness phenomena were increased. Chromatid aberrations were not seen in the first division following microwave exposure. (auth) (UK)

12054 MUTAGEN INDUCED VARIABILITY FOR OAT SEED WEIGHT IN SELECTED AND UNSELECTED POPULATIONS. Joshi, S. N.; Frey, K. J. (Iowa State Univ., Ames). Radiat. Bot.; 9: 501-7(Nov 1969).

Samples of random and selected oat seeds (for heavy weight) from thermal neutron and ethyl methanesulfonate derived populations were used to initiate a second cycle of mutagenesis with these same mutagens. Oat lines derived directly from the random and selected samples and from populations derived from new mutagen treatments were grown in a replicated field experiment and measured for 100-seed weight. The populations derived from the selected oat seeds had a mean genotypic variance component 41 percent greater than that in the population derived from the random oat seeds. With a second mutagen treatment the genotypic variance components were increased by 53 and 64 percent in the random and selected materials, respectively. Recurrent treatment of selected and random samples with a mutagen reduced the mean 100-seed weight by 0.02 and 0.01 g, respectively, both being non-significant values. The variant lines produced by the second mutagen treatment of either random or selected material were distributed to both heavier and lighter seed-weight classes. The gains from a second cycle of selection were greater than the actual gains in the first. (auth) (UK)

12055 ON THE BIOLOGICAL EFFECTIVENESS OF INTERMEDIATE NEUTRONS: INDUCTION OF CHROMOSOMAL ABERRATIONS. Ahnstroem, G. (Univ. of Stockholm); Ehrenberg, L.; Natarajan, A. T.; Rosen, C.-G.; Moutschen-Dahmen, J.; Moutschen-Dahmen, M. Radiat. Bot.; 9: 449-58(Nov 1969).

Seeds of Nigella damascena and excised embryos of barley were irradiated with neutrons of maximum energies 507, 250 and 76 keV produced by (p,n) reaction with a thick Li target, and with somewhat moderated fission neutrons in the R-1 reactor at Stockholm. Neutrons of the lower energy were found to induce chromosome aberrations (minutes, dicentrics and rings, observed in the first metaphase in roots after onset of germination) with a reduced effectiveness compared to 507 keV and fission neutrons. This reduced RBE at lower neutron energy is suggested to be due to a shorter track length rather than to a changed LET. In Nigella simple chromosome breaks were induced at an increasing effectiveness with decreasing neutron energy. This relatively rare aberration type (not determinable in barley) is possibly a consequence of incomplete exchanges. Elastic nuclear collisions are not expected to play a role in the effects observed. Further approaches to study the action of neutrons at the still lower energies where this mechanism of energy dissipation predominates are discussed. (auth) (UK)

12056 THE STUDY OF SOME OXIDIZING FERMENTS IN STABILIZING RADIOMUTANTS OF COTTON PLANTS. Arslanova, S. V. (Inst. of Experimental Biology, Moscow). Uzb. Biol. Zh.; No. 4, 3-5(1969). (In Russian).

The results have shown that o-diphenol oxidase and catalase activities in radiomutants received from Gossypium hirsutum SSP punctatum are increased and in radiomutants received from 1306-DV variety are decreased. Peroxidase activity in radiomutants received from G. hirsutum SSP punctatum is decreased. (auth)

12057 SURVIVAL, DNA-BREAKDOWN, AND INDUCTION OF PROPHAGE LAMBDA IN A ESCHERICHIA COLI K 12 RECAUVRB DOUBLE MUTANT. Hertman, I. M. (Israel Inst. for Biological Research, Ness-Ziona). Genet. Res.; 14: 291-307(Dec 1969).

Cellular functions of a double mutant of Escherichia coli K 12 deficient in recombination (recA) and defective in excision of pyrimidine dimers (uvrB) were compared to those of isogenic recA and uvrB single mutants and wild type bacteria. A combined effect of the two mutations on cell survival both under normal conditions of growth and after exposure to ultraviolet light or mitomycin C was demonstrated. The ratio of optical density to the number of colony formers in growing cultures of the double mutant is three times greater than in similar cultures of the recA single mutant and 9 times greater than in either uvrB or in wild type cultures. The doubling time in growing recA uvrB cultures is 90 min, compared to 60 min for the recA single mutant and 40 min for the uvrB single mutant and wild type bacteria. Growing cultures of recA uvrB (λcI857) bacteria contain a substantial fraction of cells which are unable to form colonies at 32°C, but produce phage when heated to 42°C. No such cells were found in cultures of the single mutants or the wild type bacteria lysogenic for λcI857. The double mutant is 10 times more sensitive to ultraviolet light and twice more sensitive to mitomycin C than the recA single mutant. In contrast to recA bacteria, exposure of the double mutant to mitomycin C induces little additional breakdown of cellular DNA. Induction of the prophage by mitomycin C is, however, prevented in both recA uvrB(λ) and recA(λ) bacteria. Exposure to mitomycin C creates conditions which render the prophage inducible by a newly transduced recA gene. This effect of mitomycin C persists and can be revealed in complete medium at 37°C after 100 min of incubation. The decay of the prophage, in cells exposed to mitomycin C, proceeds at a similar rate in both the double mutant and the recA single mutant. The inability of recA lysogens to be induced to phage production is discussed in the light of the present findings. (auth)

12058 INVESTIGATIONS ON DEHYDROGENASE ACTIVITY CHANGES IN LUCERNE NODULE BACTERIA AS AFFECTED BY ULTRAVIOLET RAYS AND ETHYLENE IMINE. Semenova, V. I.; Zolotilina, G. D. (Inst. of Microbiology, Moscow). Uzb. Biol. Zh.; No. 4, 20-2(1969). (In Russian).

Data on dehydrogenase activities in different variants of lucerne (alfalfa) nodule bacteria produced by ultraviolet radiation are presented. Dehydrogenase activity changed considerably in the variants. In certain cases cultures produced by ultraviolet radiation were more active than the original strain 414-a. However, no clear correlation between dehydrogenase activities and dehydrogenase effects was found. (auth)

Health Physics and Safety

Refer also to abstract 11548.

12059 MEDICAL APPLICATIONS OF RADIONUCLIDE INSTRUMENTATION TECHNIQUES. PART V. PROTECTION AGAINST IONISING RADIATION. Barnaby, C. F. (University Coll. Hospital Medical School, London). World Med. Electron.; 6: 94-100(Apr 1968).

Natural and man-made sources of radiation are listed and discussed. The Medical Research Council's figures based on the recommendations of the International Commission on Radiological Protection for "maximum permissible levels" are given. The responsibility chain for protective measures against hazards arising from the use of radionuclides in hospitals is stated. The education of workers in self protection is emphasized and methods are outlined to effect reduction of exposure. The handling, monitoring, storage and emergency procedures for both sealed and unsealed sources are discussed. (UK)

Radioactive Contamination and Decontamination

Refer also to abstracts 11904, 11927, 12022–12024, 12028–12033, 12036, and 12039.

12060 (AEC-tr-7128, pp 62-5) RADIOECOLOGICAL STUDIES IN THE MURUROA ATOLL (TUAMOTU IS.) REGION. Kolesnikov, A. N.; Barinov, G. V.; Zesenko, A. Y. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). Translated from report A-AC-82/G/L-1254.

Investigations were conducted on the radioactivity of plankton in the Pacific Ocean in the region of the Tuamotu Archipelago north of the French atomic proving ground on Mururoa Atoll. Methods of collecting plankton samples are described; zooplankton consisted chiefly of copepods, siphonophores, and euphausids. The radioactivity of plankton at various distances from the Mururoa Atoll was measured and results are tabulated for ^{141}Ce, ^{144}Ce, ^{103}Ru, ^{95}Nb, and ^{95}Zr. The greater the distance from the Atoll, the smaller was the activity of the samples. Anomalies in a

crustacean, Pleuromamma piseki, were observed; the anomaly occurred in all specimens near the Atoll, but there was a decrease in incidence of anomalies with distance from the Atoll. (H.L.W.)

12061 (AEC-tr-7128, pp 112-26) QUANTITATIVE CHARACTERISTICS OF THE RELATION BETWEEN THE ENVIRONMENTAL CONTAMINATION LEVELS AND RADIOISOTOPE CONCENTRATIONS IN SELECTED TYPES OF FARM PRODUCE. Fedorov, E. A.; Romanov, G. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). Translation of report A-AC-82/G/L-1286.

Studies on the effects of the environment on radioisotopes and the effects of global fallout on contamination levels of farm produce led to the determination of proportionality factors for certain farm products. Establishment of these quantities made it possible to estimate the contamination of farm products for known levels of radioactive fallout and a known content of radioisotopes in the soil. Tables are presented to show soil proportionality factors for ^{137}Cs, ^{144}Ce, ^{106}Ru, ^{89}Sr, and ^{90}Sr in hay, wheat, leafy vegetables, potatoes, and root vegetables. Data on uranium concentrations in farm crops show that there is a close relationship to the content of the available form of the uranium in the soil. A formula is presented for determining the air proportionality factor for ^{131}I. Ratios between levels of ^{90}Sr and ^{137}Cs contents of milk and fallout levels were studied. (H.L.W.)

12062 (AEC-tr-7128, pp 152-62) SOME QUANTITATIVE CHARACTERISTICS OF THE DIRECT CONTAMINATION OF THE ABOVE-GROUND PART OF PLANTS BY GLOBAL RADIOACTIVE FALLOUT. Romanov, G. N.; Ukhanova, V. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). Translation of report A-AC-82/G/L-1291.

Average monthly fallout densities of radioactive fission products were analyzed and results are tabulated. Studies were conducted on direct contamination of plants by radioactive fallout and assimilation by the root system of radioisotopes in the soil. Tables are presented to show radioactivity of ^{144}Ce, ^{137}Cs, ^{106}Ru, ^{90}Sr, and ^{95}Zr in herbaceous plants, green wheat, wheat grain, sugar beets, and root vegetables. It was concluded that direct contamination of various types of agricultural plants by radioactive fallout arises from the initial holding and its subsequent removal under the effect of environmental factors. (H.L.W.)

12063 (AEC-tr-7128, pp 208-13) CHANGES IN THE CONCENTRATION OF ^{90}Sr AND ^{137}Cs IN VARIOUS FOODSTUFFS OVER THE PERIOD 1957-1967. Shvydko, N. S.; Perova, A. A.; Dikaya, Ch. Ya.; Antonova, V. A.; Vyamushkina, N. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). Translation of report A-AC-82/G/L-1299.

It was determined that more than 80% of the uptake of ^{137}Cs and ^{90}Sr by human populations occurred through milk and bread products. Accordingly, monitoring studies were carried out on milk and grain. Variations in the mean densities of ^{137}Cs and ^{90}Sr fallout during the period 1957 to 1967 are identical with variations in the mean content of the radionuclides in grain. The ratio of ^{137}Cs to ^{90}Sr in milk was higher throughout this period than the ratio of their content in the fallout. This indicated that there was an enrichment of ^{137}Cs in milk. Data on contamination of milk with ^{90}Sr indicated that there was a definite contribution from the soil through roots as well as that from leaves. (H.L.W.)

12064 (AEC-tr-7128, pp 235-45) STUDY OF THE UPTAKE OF AIR-BORNE ^{239}Pu BY THE HUMAN ORGANISM. Smorodintseva, G. I.; Tarasov, S. I.; Oreshina, A. F.; Shalak, N. I.; Yaskova, V. Z. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). Translation of report A-AC-82/G/L-1301.

Data are presented for ^{239}Pu concentrations in atmospheric air, human lungs, and lymph nodes during the period 1964 to 1966. Methods of investigation and calculation are described. It was found that the level of ^{239}Pu in atmospheric air was four orders lower than the MPD for the whole population. Plutonium-239 doses in the lungs were 3000 times lower than the MPD for the lungs and 40 times lower than the dose resulting from ^{210}Po. The data served to some extent as confirmation of the exponential model adopted by the ICRP for calculating the ^{239}Pu content of human lungs from its concentration in the air. (H.L.W.)

12065 HEALTH PHYSICS CONSIDERATIONS IN THE USE OF RADIOACTIVE FOILS FOR GAS CHROMATOGRAPHY DETECTORS. Howley, John R.; Robins, Charles; Brown, J. M. Jr. (National Inst. of Health, Bethesda, Md.). Health Phys.; 18: 76-8(Jan 1970).

The radiation hazards arising from the use of radioactive foils as ionizing agents in the gas detector chambers of gas liquid chromatography equipment are discussed. The dose rates encountered on cleaning the foils are listed. It is urged that the suggested precautions should be taken when handling detector cells and foils. (UK)

Dosimetry and Monitoring

Refer also to abstracts 11771, 11773, 11774, 11851, 11897, 11928, 12102, 12177, 12134, 12193, 12195, 12275, 12325, 12874, and 13262.

12066 (BNWL-1183-1) THE MEASUREMENT OF RADIATION EXPOSURE OF ASTRONAUTS BY RADIOCHEMICAL TECHNIQUES. DETERMINATION OF THE RADIONUCLIDE CONTENT OF FECES AND URINE FROM ASTRONAUTS ENGAGED IN SPACE FLIGHT. Quarterly Research Report to the NASA Manned Spacecraft Center, April 8-June 30, 1969. Brodzinski, R. L.; Palmer, H. E.; Rancitelli, L. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 15, 1969. Contract AT(45-1)-1830. 50p. Dep. CFSTI.

A study of the quantities of radioisotopes present in the feces and urine of the astronauts from the Apollo 7, 8, 9, and 10 missions was completed. Observed radioisotopes were ^{7}Be, ^{60}Co, ^{51}Cr, ^{137}Cs, ^{59}Fe, ^{40}K, ^{22}Na, and ^{24}Na. The ^{60}Co, ^{51}Cr, and ^{59}Fe were from preflight injection; the ^{137}Cs and ^{40}K were naturally occurring or normally present; the ^{7}Be and ^{22}Na were both of normally occurring and cosmogenic origins; the ^{24}Na was cosmogenic. Evaluation of the data indicated that the Apollo 7 mission astronauts were exposed to protons with an average effective energy of 38 to 40 MeV. The radiation dose received by Apollo 7 mission astronauts was 480 ± 310 mrads at the 65% confidence level. The radiation dose received by the Apollo 9 mission astronauts was less than 315 mrads. The radiation dose received by the Apollo 10 mission astronauts was 870 ± 550 mrads. Progress in studies concerned with postflight neutron activation analysis of feces and urine of astronauts, induced radioisotopes in the spacecraft, and content of promethium-147 in the space capsule environment is also reported. The procedure and results of the calibration of the NASA whole-body counter and recommendations for whole-body counting of astronauts are presented. (C.O.)

12067 (RD/BN-1480) BIOLOGICAL ASPECTS OF SKIN IRRADIATION. PART II. SKIN THICKNESS CORRECTIONS TO DOSE ESTIMATES. Whitton, J. T. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Nov 1969. 14p. Dep. CFSTI (U. S. Sales Only).

The reliability of skin dose measurements depends critically on values assumed for the depth below the skin surface and the thickness of the skin layer occupied by the biologically sensitive tissue (basal layer). The main errors in using skin dosimeters, employing both lithium fluoride in powder form and in teflon discs, arise through discrepancies between the thicknesses of the containing sachet window and phosphor layer when compared with the thicknesses of the protective and sensitive skin layers. Preliminary results from an experimental survey of probable skin dimensions at various body sites are quoted and data are presented by which skin dose estimated using these new parameters differs from that measured by a thermoluminescent skin dosimeter. The conclusions may be used to indicate the magnitude and direction of errors in dose estimations. (auth) (UK)

12068 (RHEL/M-149) DEPTH DOSE AND DEPTH DOSE EQUIVALENT DATA AS FUNCTIONS OF NEUTRON ENERGY. Shaw, K. B.; Stevenson, G. R.; Thomas, R. H. (Rutherford High Energy Lab., Chilton (England)). Sep 1968. 15p. Dep. CFSTI (U. S. Sales Only).

Depth dose and depth dose equivalent data as functions of neutron energy are reported from various authors. Smooth curves were drawn through the sets of data and values for specific tissue depths of dose and dose equivalent per unit fluence as a function of neutron energy from thermal to several GeV are listed. (auth)

12069 SPECIFIC ABSORBED FRACTIONS FOR PHOTON POINT SOURCES WITHIN A SCATTERING MEDIUM. Ellett, W. H. (Royal Postgraduate Medical School, London). Phys. Med. Biol.; 14: 615-26(Oct 1969).

Dose distributions from point γ-ray sources within bound and unbound tissue-like absorbers were obtained by means of Monte Carlo calculations. Results are presented for source energies ranging from 30 to 2750 keV. These results are compared with approximate dose distributions utilizing an "effective" absorption coefficient and with moment method calculations of the dose distribution within an infinite water phantom. Boundary effects were evaluated by comparing the dose in spheres of radii 10, 20, 30 and 40 cm with the dose in an unbounded absorber. In some cases, the introduction of a non-reflecting boundary reduces the

dose at the boundary by nearly a factor of two. However, boundary effects are shown to be unimportant at distances greater than one mean free path from a non-reflecting interface. (auth) (UK)

12070 FERROUS SULPHATE G-VALUES FOR X-RAYS OF "EFFECTIVE" ENERGY 48 AND 25 keV. Law, J. (Royal Infirmary, Edinburgh). Phys. Med. Biol.; 14: 607-14(Oct 1969).

Measurements were made of ferrous sulfate G-values for x-ray beams of 250 and 50 kV, having mean photon energies of 48 and 25 keV. A Baldwin–Farmer ion chamber calibrated at the N.P.L. was used at the higher energy, and a free air chamber at the lower energy. The results for 0.8N H_2SO_4 dosemeter solutions were 14.3 ± 0.3 and 13.7 ± 0.3 ions per 100 eV, while at 48 keV for 0.1N H_2SO_4 solutions the result was 14.1 ± 0.3 ions per 100 eV, with a G-value ratio for the two acid strengths of 1.011 ± 0.007. The G-value literature for photon energies below 100 keV is briefly reviewed and used as the basis for a table of recommended values in this photon energy range. (auth) (UK)

12071 RADIATION CONTROL IN N.S.W. Foskett, W. E. (Dept. of Public Health, Sydney). Health N.S.W.; 10: 5-7 (May 1969).

Regulatory control of the use of ionizing radiation in New South Wales is maintained through the Radioactive Substances Act and Regulations, administered by the Radiation Branch, Division of Occupational Health, N.S.W. Department of Public Health. All persons who possess, use or sell radioisotopes, or who possess and use x-ray equipment must be licensed. The Radiation Branch investigates all uses of x-rays and radioisotopes and carries out routine inspections of equipment and procedures. The Branch checks air, food and water for radioactive contamination, to ensure that international limits, incorporated in New South Wales legislation, are not exceeded. It operates a free film badge monitoring service for radiation workers. Statistics of the total number of radiation workers supplied with film badge monitors from 1960 through 1968 are given. (Australia)

12072 PREDICTING THE MINIMUM ACTIVITY REQUIRED FOR THYROID-UPTAKE STUDIES. Metz, Charles E. (Univ. of Pennsylvania, Philadelphia). J. Nucl. Med.; 10: 475-9 (Jul 1969).

An expression was developed that permits calculation of the administered activity required for acceptable statistical accuracy in the thyroid-uptake study using any given set of clinical parameters. Approximately 1 μCi of ^{131}I was sufficient for studies done using a scintillation detector with a 2 × 2-in. crystal and a total counting time of 5 min. (auth)

12073 RADIATION HAZARDS FROM DIAGNOSTIC RADIOLOGY. Matthews, J. C.; Miller, H. (Regional Medical Physics Dept., Sheffield, Eng.). Brit. J. Radiol.; 42: 814-17(Nov 1969).

A follow-up survey of doses from diagnostic radiology in the Sheffield Hospital region over an eighteen month period ending Spring 1965, is described briefly. Radiological departments in the area gave total numbers of cases radiographed during one representative week. Measurements of patient dose were made in as many hospitals as possible and an average gonad dose deduced for each type of case. Finally an attempt was made to deduce the genetic dose of the population. Measurements, methods of recording and deducing gonad doses were identical with those used in the 1957–1958 Report of the Committee on Radiological Hazards to Patients (Published 1960). There was some evidence of a reduction of the overall genetic dose to the population arising from diagnostic radiography, but nothing like the 20% which appeared possible if all the recommendations of the Committee's report were carried out. (UK)

12074 AUTOMATIC ISODOSE RECORDER. Anttila, Pentii; Eklund, Jan; Spring, Erik (Univ. Central Hospital, Helsinki). Strahlentherapie; 138: 417-22(Oct 1969).

A recorder was constructed for the automatic determination of isodose distribution charts of ionizing radiation. This recorder can be used for measurement of radiation from radium applicators, cobalt and cesium sources, linear accelerators and betatrons, and also for the corresponding measurements from films which were exposed to the radiation concerned. (auth)

12075 ELECTRON DEPTH THERAPY WITH PENDULUM RADIATION. PART II. SEVERAL CHARACTERISTICS OF DOSE DISTRIBUTION IN THE ALDERSON PHANTOM. Rassow, Juergen; Strueter, Horst-Dieter; Bernert, Joachim; Krabb, Hans-Juergen (Ruhr Univ., Essen). Strahlentherapie; 138: 385-93 (Oct 1969). (In German).

Deep-seated tumors in the thorax or mid- and lower abdomen of an Alderson phantom were irradiated with moving beam techniques on the 42 MeV Siemens Betatron. The dosimetry was made by films. The reproducibility of the technique is demonstrated. The isodoses of 80% have a nearly circular form, whose extent corresponds well to the field width. Depending on the technical parameters the dose maximum lies before or behind the pendle axis, which is nearly always situated within the 90% isodose. Enlarging the field, an asymmetrical position of the pendle axis or changing the pendle angle has distinct influence on the isodose configuration. Comparing the electrons, X-rays of 43 MeV, or cobalt-60 gamma rays, it is shown that the lowest integral dose is obtained with electrons. Tissue heterogeneities have almost no influence. A pendular irradiation in the urinary bladder does not affect the bony pelvis. (auth)

12076 BEHAVIOR OF FAST ELECTRONS FROM THE VIEWPOINT OF RADIOTHERAPEUTIC REQUIREMENTS. PART III. BEHAVIOR OF FAST ELECTRONS HITTING CURVED SURFACES. Vogel, Karl-Heinz (Medizinische Strahleninstitut, Tuebingen, Ger.). Strahlentherapie; 138: 398-403(Oct 1969). (In German).

The usual anatomical contour forms differ noteworthily from the flat surface, for whom the usual isodoses are established. The influence on the dose distribution for last electrons was studied. This influence is not only found below the surface, but also at any depth, even up to the end of the electron range, so that the homogeneity of the tumor dose can be questioned. This influence must then be taken into account in the treatment planning. (auth)

12077 METABOLIC BEHAVIOR AND RADIATION DOSIMETRY OF ^{99m}Tc-ALBUMIN IN PREGNANCY. Herbert, Russell J. T.; Hibbard, Bryan M.; Sheppard, Margaret A. (Liverpool Clinic. Univ. of Liverpool). J. Nucl. Med.; 10: 224-32(May 1969).

A cross-sectional study of the metabolic behavior of ^{99m}Tc-albumin after intravenous injection to pregnant women was carried out. Serial measurements of the radioactivity of maternal plasma, maternal and infant urine excretion, umbilical cord blood, liquor amnii, neonatal thyroid and whole body were made. A relation between percentage uptake and time has been established for these organs and tissues and the radiation exposures in μCi-hr/100 μCi obtained. From these results the radiation doses for mother and fetus have been calculated; maternal gonads, 3.8 mrems/100 μCi; fetal gonads, 1.2 mrems/100 μCi and fetal thyroid, 2.8 mrems/100 μCi. (auth)

12078 QUANTITATIVE MEASUREMENT OF RADIOACTIVITY IN INTERNAL ORGANS BY AREA SCANNING. Arimizu, Noboru; Morris, A. C. Jr. (Oak Ridge Associated Universities, Tenn.). J. Nucl. Med.; 10: 265-9(June 1969).

Conventional area scans display a representation of the radionuclide present in a patient. A number of methods, such as computer processing and color recording, have been used to increase contrast and diagnostic interpretability. These scans and manipulative processes do not quantitate the radionuclide present. Our work has been directed toward finding a method for calculating organ-uptake values simultaneously with a scanning procedure. More than 850 experimental scans have been made on various radioactive sources and phantoms to obtain the basic information needed. The method developed makes use of two scan records produced from above and below the patient; then, for each scan, the counts or dots are summed over the selected organ. If the summing area for each scan record is properly chosen around the perimeter of the organ, the number of scan counts depends on the source depth but not on its size. Calculations on the summed counts from both opposed scans provide an accurate uptake measurement, independent of both source depth and configuration. High accuracies have been consistently maintained when this method was tested with radioactive plastic organs in a water-filled human REMAB phantom. (auth)

12079 RELATIONSHIP BETWEEN THE DOSE DISTRIBUTION IN MOBILE GAMMA-THERAPY WITH DIFFERENT PARAMETERS AND THE CHOICE OF IRRADIATION CONDITIONS. Zevrieva, I. F. (Inst. for Research in Oncology and Radiology, Alma-Ata, USSR). Med. Radiol..; 14: No. 11, 67-72(Nov 1969). (In Russian).

Results of an investigation into the relation of the dose distribution along the bisector of the swing angle and several parameters, such as the magnitude of the swing angle, the field size on the swing axis, the depth of the rotation center, dimensions, and the shape of cross-sections are presented. The data offered in the form of charts, tables, and curves are convenient for practical use. An example involving the choice of conditions for irradiation of the esophageal tumor is discussed. (auth)

12080 DOSIMETRY OF ^{192}Ir PINS. THEORETICAL STUDY ON COMPUTER. Paine, Ch.; Pierquin, B.; Dutreix, A.; Chassagne, D. (Institut Gustave-Roussy, Villejuif, France). Ann. Radiol.; 12: R549-55(1969). (In French).

The dose distribution for a double pin and for a single pin was studied on a computer for the center of the pins and around the two extremities. The study made it possible to define with precision the limits of the volume treated for pins of different lengths. (J.S.R.)

12081 DATA. SECTION IV. OTHER DATA. Radiol. Health Data Rep., 10: 467-73(Oct. 1969).

Summaries of environmental monitoring programs at the Lawrence Radiation Laboratory during 1968 including data from the Berkeley Site, the Livermore Site, and Site 300 are presented. Tables are presented to show concentrations of α and β radioactivity in the atmosphere, water, and total deposition. Results of monitoring programs at the Shippingport Atomic Power station include data from Ohio River sediment and water analyses, liquid and gaseous radioactive waste monitoring, film badge monitoring, and fallout monitoring. It was concluded that during 1968 the radioactive effluent releases from the Shippingport station site did not cause any significant increase in background radiation levels. The station procedures relative to controlling radioactive discharges to the environment were considered to be effective in protecting the health and safety of the general public. (H.L.W.)

12082 DATA. SECTION III. AIR AND DEPOSITION. Radiol. Health Data Rep., 10: 455-66(Oct. 1969).

Surveillance data from the U. S. Public Health Service, the Canadian Department of National Health and Welfare, The Mexican Commission of Nuclear Energy, and the Pan American Health Organization are summarized to show current and long-range trends of atmospheric radioactivity in the western hemisphere. The gross β radioactivity in surface air and precipitation during June 1969 in the United States and Canada; the gross β radioactivity of airborne particulates during September and October 1968 in Mexico; ^{90}Sr fallout during January to June 1968 in the United States; ^{90}Sr fallout in North and South America during January to June 1968; ^{238}Pu and ^{239}Pu content of precipitation during April to June 1968; and Pu content of airborne particulates during April to June 1968 are presented in tabular form. (H.L.W.)

12083 DATA. SECTION II. WATER. Radiol. Health Data Rep., 10: 451-3(Oct. 1969).

Public Health Service drinking water standards, based on consideration of Federal Radiation Council recommendations, set the limits for approval of a drinking water supply containing ^{226}Ra and ^{90}Sr as 3 pCi/liter and 10 pCi/liter respectively. Results of monitoring gross α and β radioactivity in surface waters of the United States for March, 1969, as a part of the Water Pollution Surveillance System are tabulated. Special note is taken when the α radioactivity is 15 pCi/liter or greater or when the β radioactivity is 150 pCi/liter or greater. During March, 1969, a station in Colorado and one in Nebraska showed α values in excess of 15 pCi; none of the stations showed β values in excess of 150 pCi. (H.L.W.)

12084 THE ADAPTATION OF A TABLE-TOP COMPUTER TO COMPLETE ^{60}Co RADIATION THERAPY DOSIMETRY AND TREATMENT PLANNING. I. DOSIMETRIC CALCULATION. Koplow, Harold; Feldman, Merrill I.; Spira, Jacob (Lynn Hospital, Mass. Wang Labs., Inc., Tewksbury, Mass.). Radiology; 93: 1113-16(Nov 1969).

The formulas and data used in programming a Wang Model 370 desk-top electronic digital computer for ^{60}Co dosimetry are described and outlined. This material is now available on verified punch cards for repeated use, thereby eliminating time-consuming, error-prone manual calculations. All programs are available from the authors upon request. (auth)

12085 CALCULATED AND EXPERIMENTALLY DETERMINED NEUTRON DOSE CONVERSION FACTOR FOR CALIFORNIUM. Stone, D. R.; Wagner, E. B.; Jones, T. D.; Shinpaugh, W. H. (Oak Ridge National Lab., Tenn.). Health Phys.; 18: 69-71(Jan 1970).

A dose rate conversion factor for ^{252}Cf of 3.0×10^{-9} rad neutron^{-1} cm^2 was computed using a theoretical spectrum and a general expression for the first collision dose assuming isotropic scattering. Two independent dosimetry systems were used to determine the factor experimentally. The values thus obtained agreed to within 3% and 4% respectively of the calculated value and thus the recommended dose conversion factor for ^{252}Cf is $3.0 \pm 0.1 \times 10^{-9}$ rad neutron^{-1} cm^2. (UK)

12086 A DERIVATION OF THE FACTOR OF 700 FOR ^{131}I. Burnett, Thomas J. (Oak Ridge National Lab., Tenn.). Health Phys.; 18: 73-5(Jan 1970).

Calculations are given in detail to explain the basis for the term, factor of 700, for ^{131}I that is used in reactor hazard calculations. Comments on the interpretation are invited as misunderstanding of the term has been noted. (UK)

12087 DOSIMETRY AND RADIOPROTECTION IN X RAY CONTACT THERAPY. Garsou, J. (Univ., Liege). J. Belge Radiol.; 52: XXIII-XXVI(1969). (In French).

The technique used for measuring the distribution and importance of radiation originating from tissues treated by x-ray contact therapy is described. Certain essential precautions to be taken to ensure the protection of the workers using this technique are recommended. (auth)

12088 THE QUESTION OF RADIATION EXPOSURE TO THE HAND FROM HANDLING ^{99m}Tc. Neil, C. M. (St. Joseph Hospital, Houston, Tex.). J. Nucl. Med.; 10: 732-4(Dec 1969).

At some levels of nuclear medicine laboratory testing of patients, peak hand radiation exposure to the technicians may exceed regulatory levels by a modest amount. Monitoring of hand radiation exposure may be desirable, depending on certain conditions peculiar to each laboratory. Whole-body and finger ring film badges are not necessarily representative of peak hand radiation exposure from ^{99m}Tc and may lead to a sense of security which is not justified. Measurements using thermoluminescent detectors showed there is a steep radiation dose gradient of approximately 20 to 1 from peak to minimum hand radiation values for ^{99m}Tc. A value of 10 mRem/mCi-min is suggested for calculating peak hand radiation exposure levels to ^{99m}Tc. (auth)

12089 DOSIMETRY OF ^{132}I. Charkes, N. David (Temple Univ. Medical School, Philadelphia). J. Nucl. Med.; 10: 752 (Dec 1969).

Methods for the dosimetry of ^{132}I in human thyroid glands are described. The radiation dose to the thyroid gland was determined to be 7.6 Rads/mCi ^{132}I administered. (C.H.)

Radiation Protection

Refer also to abstracts 11860, 12102, and 12228.

12090 (CEA-R-3874) HEALTH PHYSICS PROBLEMS DUE TO TRITIUM AROUND HEAVY-WATER REACTORS. Chassany, Jean; Roux, Jean M. (Commissariat a l'Energie Atomique, Chuscian (France). Centre de Production de Plutonium de Marcoule). Dec 1969. 24p. (In French). Dep. CFSTI (U. S. Sales Only).

Following one year of operation of a heavy-water reactor, a review is presented of the protection against tritium. The nature of the tritium risk peculiar to this type of installation is discussed, as well as detection and measurement equipment, working methods, and results obtained concerning the supervision of the personnel, the installation, and the servicing operations. (auth)

12091 (ORNL-tr-2253) SOME PROBLEMS OF RADIATION PROTECTION IN SPACE FLIGHTS. PART III. Swart, H. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Astron. Raumfahrt; 5: [No. 2], 57-64(1967). 10p. Dep. CFSTI.

It has been shown that cosmic flights require more or less troublesome protective measures against radiation which, according to the intended mission, are concentrated mainly in the following four areas: shielding, radiation control and warning, dosimetry, and health protection. Each of these is discussed. Although radiation protection in cosmic flights still involves many unsolved problems, it is concluded that the various cosmic radiations represent no great hindrance to space flights. With progressing development of science and technology reliable radiation protection for interplanetary journeys lasting several years will be achieved. In the case of earth orbits below the radiation belt and for the approaching moon flights, even today the cosmonauts can be afforded sufficient protection. (C.O.)

12092 ADMINISTRATIVE CRITERIA FOR THE "DESIGNATION" OF PERSONS WORKING WITH UNSEALED SOURCES OF RADIOACTIVE SUBSTANCES. Hughes, D. (Univ. of Leeds, Eng.). Nature (London); 224: 728(15 Nov 1969).

Work with radioactive substances in universities and hospitals is subject to codes of practice which require the designation of persons involved unless it is most unlikely that they will receive more than 0.3 of the annual maximum permissible doses. This criterion is easier to apply to persons exposed only to external radiation than to those using unsealed radioactive substances involving the additional requirement of adequate precautions against contamination. Two cases relating to the hazards of inhalation or ingestion of radioactive material are considered—first, exposure after an accident involving an unsealed source, and second, chronic exposure to small losses of the material during experimental work. Tables are given showing inhaled fractions of total activity handled for accidents involving various types of operations (glove boxes, ventilated areas, non-ventilated areas, solids, aqueous solutions,

ambient and elevated temperatures) and also maximum activities of nuclides which may be used by a non-designated individual. These data provide an administrative basis for the designation of persons working with unsealed sources. (UK)

12093 HEALTH PHYSICS IN THE USE OF NON-IONISING RADIATIONS. Oliver, R. (Churchill Hospital, Oxford). Health Phys.; 18: 85-6(Jan 1970).

A review is given of health physics practice in the field of ionising radiations, and it is urged that the knowledge and experience thus gained should be used now to supervise and control other electromagnetic radiations; for example, from r.f. and laser sources. (UK)

12094 RADIATION PROTECTION PROVIDED BY STANDARD PASSENGER BUSES. Summers, Robert L.; Burson, Zohie C. (EG and G, Inc., Las Vegas, Nev.). Health Phys.; 18: 87(Jan 1970).

The radiation protection provided by three standard passenger buses was measured using radiation from a simulated infinite plane source of ^{60}Co. With an ionization chamber as detector, protection factors of between 1.4 and 1.9 were obtained. These results could be useful in planning evacuation of personnel from fall-out contamination areas. (UK)

Safety Procedures

Refer also to abstract 12092.

12095 (LFEN-101-b) HAZARDS STUDY OF THE EUROCHEMIC PLANT FUEL RECEPTION AND STORAGE BUILDING CONCEIVABLE ACCIDENTS. Vaz Carreiro, J. (Junta de Energia Nuclear, Sacavem (Portugal). Laboratorio de Fisica e Engenharia Nucleares). 1969. 23p. Dep. CFSTI (U. S. Sales Only).

Some selected types of accidents that may occur in the Fuel Reception and Storage Building are analyzed. The principal potential hazards in this building are nuclear, such as loss of shielding, criticality incident, or release of radioactivity. Security measures are taken to cope with these hazards, however, accidents owing to malfunction of equipment cannot be excluded. A number of potential accidents are described, and the possible causes, consequences, and the existing protective measures for each accident are discussed. Assumptions are made in such a way as to be easily applied to other circumstances, thus providing a simple means of roughly estimating doses for any type of radiation accident. (C.H.)

12096 (STI/PUB-151) RADIATION PROTECTION IN THE MINING AND MILLING OF RADIOACTIVE ORES. CODE OF PRACTIVE AND TECHNICAL ADDENDUM. (International Atomic Energy Agency, Vienna (Austria)). 1968. 108p. IAEA $2.00.

A code of practice for the guidance of those with responsibilities for the radiation protection of personnel engaged in the mining and milling of radioactive ores is presented. The various radiation hazards to which mining and milling personnel may be exposed are reviewed. It is pointed out that the mining and milling of radioactive ores result in the production of radioactive wastes, which may present a potential hazard to the public and standards for radiation protection should be applied to waste disposal. Maximum permissible radiation doses for personnel and the need for records of radiation doses to personnel are discussed. It is pointed out that preference in methods of radiation protection should be given to protection permanently built into the installation rather than to personal protective equipment, and that every effort should be made to reduce the level of both external and internal exposure of workers to the lowest possible level. The need for a competent person to supervise the application of radiation protection regulations and for instruction of personnel in radiation protection is discussed. Protective measures discussed include air and area monitoring, personal dosimetry, age restrictions for personnel, periodic medical examination of personnel, dust control, adequate ventilation systems, the provision of suitable lunch facilities, and the provision of protective clothing and respirators when indicated. A separate section on radiation protection in uranium mines and mills is appended. (C.H.)

12097 CAPILLARY CIRCULATION IN CHRONIC EXPOSURE TO THE RADIATION EFFECTS. Smirnova, M. I.; Denisova, E. A. (Inst. of Industrial Hygiene and Occupational Disease, Moscow). Med. Radiol.; 14: No. 11, 43-6(Nov 1969). (In Russian).

The time of the ^{131}I resorption from the intradermal repository was studied in 129 persons exposed occupationally to the effects of the ionizing radiation sources and in 27 controls. Most of the persons examined were middle-aged males. The syndrome of neurocirculatory dystonia was diagnosed in all of them. Slowing down of the ^{131}I resorption was recorded in a considerable proportion of those examined in the basic group; it was especially marked in subjects with the syndrome of neurocirculatory dystonia of the hypertensive type. The delayed ^{131}I resorption is attributed to the presence of a spastic or spastico-atonic state of the capillaries, which leads to the diminution of the total capillary stream. (auth)

12098 ACCIDENTAL EXTREMITY EXPOSURES FROM ANALYTICAL X-RAY BEAMS. Mathews, Jimmy D. (Ohio Univ., Athens). Health Phys.; 18: 75-6(Jan 1970).

Two accidental exposures of the fingers of the right hand from an x-ray beam are reported. All relevant characteristics of the X-ray unit and exposure data are listed. Calculation of the exposure gives values of 650 R and 750 R. No effect on skin or blood count was noted during the two weeks following the exposure. (UK)

12099 EVALUATION OF LASER HAZARDS TO THE EYE AND THE SKIN. Burnett, W. D. (Sandia Lab., Albuquerque, N. Mex.). Amer. Ind. Hyg. Ass. J.; 30: 582-7(Nov-Dec 1969).

Laser eye and skin hazards are evaluated by comparing direct-exposure intensity levels on the surface of the eye or skin to exposure guidelines equal to threshold effect levels where the skin or cornea is affected and conservatively safe levels based on worst case assumptions where the retina is affected. Equations are presented for calculating the exposure intensity when the laser beam parameters and the range are known. Intensity amplification factors of the eye are indicated for the three cases encountered in practice: where simple geometric optics apply, where the laser beam divergence angle is limiting, and where Fraunhofer diffraction effects are limiting. Diffraction effects predict the maximum eye intensity amplification and hence define the worst case for retinal exposure. The resultant exposure guidelines are summarized, and estimates are made of the associated safety factors. These exposure guidelines quickly identify problem areas that may require more complicated exposure equations and a careful consideration of the actual geometries and safety factors involved. (auth)

Civil Defense

12100 (FMB-69-11) REFERENCE LINES: LETHALITY DISTANCES AS A CONSEQUENCE OF NUCLEAR EXPLOSIONS FOR AN ALERTED POPULATION WITH MISSING STRUCTURAL PROTECTIVE MEASURES. PART 2. REFERENCE DIAGRAMS. Ritschard, Urs; Pretre, Serge (Forschungsinstitut fuer Militaerische Bautechnik, Zurich (Switzerland)). Oct 1969. 33p. (In German). Dep. CFSTI (U. S. Sales Only).

The effects of nuclear weapons on a population without fallout shelters are considered. Twenty-one diagrams depict lethality curves for people in the open, in cities, and in forests. Three cases of explosions are assumed: at the surface, at 100 m altitude, and at 200 m altitude. For surface explosions, calculations include downwind and upwind directions. (H.B.G.)

Legal Aspects

12101 THE IONISING RADIATIONS (UNSEALED RADIOACTIVE SUBSTANCES) REGULATIONS, 1968. Statutory Instruments 1968, No. 780. London; Her Majesty's Stationery Office (1968). 32p. 2s. 9d.

These regulations are divided into the following parts: interpretation and general; administration, notification and records; basic principles of protection; radiological supervision; medical supervision; arrangement of premises and plant; personnel protection; organization of work; monitoring and measures to deal with contamination; schedules include: maximum permissible radiation doses; maximum permissible levels of contamination and method of assessment; and classification of radionuclides. (UK)

12102 USA STANDARD N13.2-1969: GUIDE FOR ADMINISTRATIVE PRACTICES IN RADIATION MONITORING (A GUIDE FOR MANAGEMENT). Hart, J. C.; Moeller, Dade W. Nucl. Safety; 11: 39-42(Jan-Feb 1970).

Radiation protection in any nuclear-based operation is a responsibility of management. The USA Standard N13.2 is designed to provide a general review of the type and extent of monitoring needed for the safe use and application of radiation sources. This Standard may be used during the planning stages of an operation as a guide to an effective monitoring program. (auth)

Medicine

Refer also to abstract 11642.

Protective Substances

Refer also to abstracts 11960, 11961, 11965, 12005, 12221, 12224, 12242, 12265, 12277, 12286, 12287, 12326, 12329, 12335, and 12336.

12103 (STI-PUB-221) RADIATION DAMAGE AND SULPHYDRYL COMPOUNDS. Panel Proceedings Series. Proceedings of a Panel Held in Vienna, 21-25 October 1968. (International Atomic Energy Agency, Vienna (Austria)). Oct 1969. 198p. (In English and Russian). (CONF-681069). IAEA: $5.00.

Separate abstracts were prepared for the 17 papers for inclusion in NSA. Conclusions, summary and recommendations and a list of panel participants are included. (C.O.)

For abstracts of individual papers see: 11959-11962, 12221, and 12336.

12104 INVESTIGATION OF THE PENETRATION OF CERTAIN RADIOPROTECTORS INTO THE RETINA AND THEIR INFLUENCE ON THE BIOELECTRIC ACTIVITY OF THE EYE. Pushkareva, T. V.; Kalmykova, G. I.; Shchelkunova, L. I. (Ioffe Inst. of Physics and Tech., Leningrad). Radiobiologiya; 9: 711-14(1969). (In Russian).

The penetration of ^{35}S-labeled cystamine and AET into the retina of frogs and cystamine into the retina of mice was studied. The maximum accumulation of labeled AET in frogs occurs on the 15th to 20th min after administration and comprises 17 to 20% with respect to uniform distribution of this protector in the organism; the maximum accumulation of cystamine is observed at the 10th min, comprising an average of 32% with respect to a uniform distribution. Cystamine is accumulated in substantially larger amounts in the mouse retina than in the frog retina. When administered in protective concentrations it has no significant effect on the bioelectric activity of the frog eye. (tr-auth)

12105 THE STUDIES OF PHARMACOLOGICAL EFFECTS AGAINST RADIATION DAMAGES. 4. EFFECT OF THE INOSINE AND THE NEUZYM. Nakashima, Noritsugu; Yoshii, Hirofumi (Kumamoto Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 29: 400-6(July 1969). (In Japanese).

Radiation damage in rabbits and humans was treated with inosine and neuzym. The death rate was significantly decreased and blood findings indicated that the drugs were effective. The respiratory quotient of bone marrow, liver, and spleen of rats was reduced by x radiation; this effect was diminished in rats treated with inosine and neuzym. It is suggested that these drugs would be effective in reducing radiation damage in man. (NSA of Japan)

12106 RADIOSENSITIVITY AND POSSIBILITIES OF RADIOPROTECTION AND RADIOREPAIR OF NUCLEIC ACIDS IN AN EMBRYONIC ORGAN CULTURED IN VITRO. Kirrmann, J. M. (College de France, Paris). pp 67-79 of Effects of Radiation on Cellular Proliferation and Differentiation. Vienna; International Atomic Energy Agency (1968). (In French).

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco. See STI/PUB-186; CONF-680413.

An embryonic chicken intestine in an organotypical culture medium was measured for total content of nucleic acids in relation to proteins as a function of the x-ray dose and the culture period (up to 48 hr). It was found that ionizing radiation had an inhibiting effect on the nucleic acid content. This effect is reversible in 24 to 48 hr depending on the radiation dose. A similar effect was found for incorporation of ^{3}H-thymidine by irradiated explants. It was also found that the intestinal epithelium which is less radiosensitive than the mesenchyma, recovered less rapidly. This organ can be protected against the inhibition of DNA synthesis by prior treatment with cysteamine. The degree of protection observed varied with the x-ray and cysteamine doses used. Radiorepair experiments showed that it was possible to stimulate the irradiated organ's power of recovery by treating it, after irradiation, with various nucleic acids. The radiation injuries observed some hours after irradiation were diminished if certain homologous or heterologous types of RNA were added to the culture medium. Addition of DNA, on the other hand, had no effect. (auth)

12107 INFLUENCE OF RADIOPROTECTORS ON REGENERATION OF THE MUCOSA OF THE SMALL INTESTINE OF THE MOUSE AFTER X-IRRADIATION. Maisin, J. R. (Nuclear Energy Study Centre, Mol, Belgium). pp 541-57 of Effects of Radiation on Cellular Proliferation and Differentiation. Vienna; International Atomic Energy Agency (1968).

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco. See STI/PUB-186; CONF-680413.

Intestinal death occurs in mice from the third to the fifth day after doses of 1 to 10 krad and is preceded by inhibition of cell division, destruction of the crypts, shortening of the villi, and denudation of the intestinal epithelium. BALB/c mice, some of which were protected with 2-β-aminoethylisothiourea (AET) or with one of the following mixtures of chemical protectors: AET + 5-hydroxytryptamine (5-HT), AET + 5-HT + glutathione (GSH), and AET + 5-HT + GSH + cysteine, were irradiated with doses of 1350 or 2000 R of x rays (300 kV, 20 mA, dose rate 100 R/min). Mitotic activity, abnormal anaphases, size of nuclei, pyknosis and number of nuclei, migration of nuclei along the villi, and incorporation of thymidine were investigated. In all experiments, lesions appeared later and were less pronounced in the protected than in the non-protected mice. Furthermore, AET and the associations of radioprotectors appear to protect the crypt cells of the small intestine during all phases of the mitotic cycle. The best results were obtained with a mixture of AET + 5-HT + GSH + cysteine. After such treatment and a dose of 2000 R of x rays, a delay of 30 days was nevertheless needed to allow complete recovery of the duodenal mucosa. The diminution of incorporation of thymidine and the prolongation of the regeneration time are symptoms of a biochemical shock, and the importance of this in the mechanism of action of sulphydryl compounds and of mixtures of protective drugs is discussed. (auth)

12108 EFFECT OF RADIOPROTECTIVE SUBSTANCES ON GLUCOSE-6-PHOSPHATE DEHYDROGENASE. Sonka, J.; Sochorova, M.; Hilgertova, J. (Faculty of Medicine, Prague). Agressologie, 9: 513-19(July-Aug. 1968). (In French).

The mechanism of action of some radioprotective agents was investigated by studying their effects on some aspects of oxidative-reduction metabolism. The glucose-6-phosphate dehydrogenase (GPDH) activity was studied in the liver of rats injected with 67 mg γ-hydroxybutyric acid (HBA) and 28 mg AET per 200 g body wt. Both HBA and AET increased the activity of GPDH 10 to 45 min after injection; 2 to 6 hr later the activity was slightly decreased below the control level. Then it became normalized by 8 to 10 hr. The ribose content of the liver was increased by HBA and cysteine, whereas two other radioprotective agents (glutathione and cysteamine) did not affect it. Liver GPDH activity was not affected by ACTH injection. The various radioprotective agents did not change the activity of GPDH in human erythrocytes. In mice irradiated with a 650 R dose, the number of 30-day survivors was increased if HBA was given 1 hr before irradiation. However, in rats exposed to a 950 R whole-body dose, more HBA-treated rats died than control rats. The role of the radioprotective agents in stimulating the regeneration of radioinjured tissues is discussed. (BBB)

12109 DETERMINATION OF THE HYPOTHERMIC RESPONSE BY THE TOXICITY OF PROTECTORS AND THE ROLE OF HYPOTHERMIA IN THEIR RADIOPROTECTIVE ACTION. Zherebchenko, P. G.; Zaitseva, T. G. (Military-Medical Academy, Leningrad). Radiobiologiya; 9: 701-5(1969). (In Russian).

The dependence of the hypothermic response induced by thiols and 5-methoxytryptamine upon their effect was established in experiments on mice. The radioprotective activity of the preparations in mice kept at room temperature was manifested regardless of their toxicity and ability to disturb thermoregulation. In animals kept at an air temperature of +10°, the joint administration of cystaphos and 5-methoxytryptamine induces such profound hypothermia that it increases the magnitude and duration of the radioprotector effect of this combination of substances. (tr-auth)

12110 CHEMICAL PROTECTION FROM INJURY BY NEUTRONS. Sverdlov, A. G.; Mozzhukhin, A. S.; Pavlova, L. M.; Nikanorova, N. G. (Ioffe Inst. of Physics and Tech., Leningrad. Military Medical Academy, Leningrad). Radiobiologiya; 9: 706-10(1969). (In Russian).

Sulfur-containing radioprotectors (cystaphos, AET, and cystamine) possess the ability to protect animals from the effect of neutron radiation. An analysis of the dynamics of death of the animals indicated that the basic mechanism of the protection of sulfur-containing compounds from damage by neutrons is prophylaxis of injury to the intestines. A representative of the indolylalkylamines (mexamine) proved ineffective under conditions of neutron irradiation. (tr-auth)

12111 CHANGE OF RADIORESISTANCE OF MICE AFTER SEVERAL DAYS OF EXPOSURE TO HYPOXIA: RADIATION INJURY TO THE HEMOPOIETIC TISSUE. PART II. ERYTHROPOIESIS. Tribukait, Bernhard (Karolinska Institutet, Stockholm). Strahlentherapie; 138: 457-70(Oct 1969). (In German).

Radiosensitivity in mice after a 10 day stay in hypoxia corresponding to an altitude of 6000 m was examined. The modifications of the hematopoiesis were studied with the aid of the incorporation

of ^{59}Fe in the bone marrow, the spleen and in the erythrocytes. An increase in the hematopoiesis is found immediately after hypoxia, with about 50%. This decreases during the subsequent 24 hours and is completely suppressed between the second and fourteenth day until the regression of the plyglobulia. When a normal mouse is irradiated with 400 R (telecobalt), the erythropoiesis follows a cyclic pattern with minima at the 3rd, 7th, 15th, and 22nd day. A similar evolution is observed when the irradiation is done immediately or 48 hours after the end of hypoxia, while the erythropoiesis is enhanced or depressed. But in the animals irradiated after 48 hours, this is only observed after 14 days, in connection with the reactivation of the erythropoiesis. A direct relationship of the modification of the radiosensitivity and of the erythropoiesis seems not to exist. (Enhanced radiosensitivity 3 to 18 hours, decreased 24 to 72 hours after the hypoxia.) (auth)

12112 EFFECT OF ^{60}Co IRRADIATION ON THE BONE MINERAL CONTENT IN DOGS. Rissanen, Pentti; Kivimaeki, Kalervo; Paatsama, Saki (Univ. Central Hospital, Helsinki, Coll. of Veterinary Medicine, Helsinki). Strahlentherapie; 138: 445-8(Oct 1969).

The effect of ^{60}Co irradiation on the bone mineral content was studied experimentally in six growing and six adult dogs using single doses of 250-4000 rd. The mineral content was measured 4, 14 and 60 days after irradiation by a method based on the absorption of monoenergetic gamma radiation. A reduction in the mineral content was established with all the doses administered. It was at its maximum in adult dogs sacrificed 14 days after irradiation. The mineral content was almost normal in the adult dogs sacrificed 60 days after irradiation, but not in the growing dogs of the corresponding group. The decline in the mineral content was proportional to the size of the radiation doses administered. (auth)

12113 PECULIARITIES OF THE RADIOPROTECTIVE EFFECT OF SODIUM HYPOSULFITE AND METABISULFITE. Faleeva, Z. N. (Inst. of Developmental Biology, Moscow). Radiobiologiya; 9: 766-9(1969). (In Russian).

The radioprotective activity of sodium hyposulfite and metabisulfite on Ehrlich's ascitic carcinoma cells before radiation or after it was investigated. When added before irradiation, $1 \cdot 10^{-3}$ M sodium hyposulfite and $2\text{-}4 \cdot 10^{-3}$ M sodium metabisulfite do not lower the percentage of cells with chromosome rearrangements in comparison with unprotected irradiated cells. The use of these substances in the indicated doses directly after irradiation even somewhat increases the yield of damaged cells. At a sodium hyposulfite concentration of $1 \cdot 10^{-4}$ M and sodium metabisulfite concentration of $8 \cdot 10^{-4}$ M, a radioprotective effect was detected, expressed to the same degree when these substances were used immediately after irradiation. Both the investigated substances remove the inhibition of mitotic activity induced by irradiation. (tr-auth)

12114 ROLE OF HUMORAL MECHANISMS IN THE CHANGE IN THE STATE OF THE BLOOD-BRAIN BARRIER UNDER THE INFLUENCE OF LOW DOSES OF X RAYS. Gromakovskaya, M. M. (Inst. of Biological Physics, Pushchino-on-Oka, USSR). Radiobiologiya; 9: 760-3(1969). (In Russian).

In mice subjected to a single x-irradiation at a dose of 25 R, the sensitivity of the blood-brain barrier (BBB) to various influences is increased. Reserpine, administered 19 to 20 hrs before irradiation, somewhat lowers the increased sensitivity of the BBB to serotonin, noradrenalin, acetylcholine, and histamine, while dimedrol lowers the increased sensitivity to histamine. (tr-auth)

12115 EFFECTS OF SOME METABOLIC INHIBITORS ON THE RECOVERY IN X-IRRADIATED MOUSE L CELLS. Terasima, Toyozo; Yasukawa, Mieko (National Inst. of Radiological Sciences, Chiba, Japan). pp 79-86 of Comparative Cellular and Species Radiosensitivity. /Bond, Victor P.; Sugahara, Tsutomu (eds.). Tokyo; Igaku Shoin Ltd. (1969).

From Conference on Comparative Cellular and Species Radiosensitivity in Animals, Kyoto, Japan. See CONF-680518.

Some metabolic inhibitors were tested for an effect on the recovery process detected by two-dose fractionation experiment of mouse L_5 cells. Cycloheximide, actinomycin D and 5-fluorodeoxyuridine were unsuccessful in preventing the recovery when added at the time of the first exposure, whereas proflavin and phleomycin were effective. On the basis of experimental results obtained and common properties found in the recovery-inhibiting drugs, it was suggested that at least one pre-existing enzyme among DNA-related enzymes is involved in the recovery process. Elkind type of recovery of mouse L cells detected by two-dose fractionation experiment begins immediately after the first irradiation and generally attains the maximal survival in a few hours. In searching for the nature of this type of recovery, effects of some metabolic inhibitors were investigated using the early steps of recovery of L cells damaged by x rays. (auth)

12116 HOMOGENATES OF THE SPLEEN IN CONDITIONS OF BLOCKING OF THE RETICULO-ENDOTHELIAL SYSTEM IN THE MOUSE. II. RADIOPROTECTIVE ACTIVITY. Cifaldi, S.; Falconi, C.; De Bella, G.; Muto, V. (Univ. of Naples). Boll. Soc. Ital. Biol. Sper., 44: 2002-3(Dec. 15, 1968). (In Italian).

The radioprotective activity of spleen homogenates under conditions of blocking of the reticulo-endothelial system was studied in mice exposed to a single dose of 625 R, a dose causing 95% mortality within 30 days after the irradiation. The spleen homogenates were administered to normal animals and to splenectomized animals. A third series of irradiated animals received no spleen homogenates. The results showed that the survival rate in the normal mice was 14%. Spleen homogenates gave no protective effect to splenectomized animals. (J.S.R.)

12117 ON THE EFFICACY OF ACTH IN THE PROPHYLAXIS OF ACUTE RADIATION DISEASE. Rogozkin, V. D.; Musabekov, D. T.; Shapiro, G. A. Buyil. Eksp. Biol. Med.; 68: No. 9, 30-2 (Sep 1969). (In Russian).

Experiments on mice, rats, and dogs were used to study the radioprotective action of ACTH given intravenously for short periods (up to half an hour) prior to acute irradiation (dogs—300 R, rats—600 R, mice—700 R). Efficacy of the agent was judged by the clinical course of the disease, change of the morphological composition of the blood, survival rate, and the dynamics of the adrenocortical activity. ACTH exerted a protective action manifested by decreased mortality of the irradiated animals, especially of rats, and less marked leukopenia during the period of radiation sickness. Animals that had ACTH prior to irradiation had a higher level of 11-oxycorticosteroids in the blood during the first hours after irradiation than the control animals. (auth)

12118 CHEMICAL SENSITIZATION OF RADIATION INJURIES TO RAT EMBRYOS. Michel, Ch.; Fritz-Niggli, H. (Univ., Zurich). Experientia; 25: 1135-6(15 Nov 1969). (In German).

Nine-day rat embryos were x-irradiated in utero one hr after injection with iodoacetamide; on the thirteenth day the animals were killed and the fetuses were examined. Of 246 implantations 36 post-implantation deaths occurred. Of 235 fetuses that were x-irradiated but not treated with iodoacetamide, only 19 were killed. Small doses of radiation caused macroscopic anomalies of the eyes; these were taken to be the chief criteria of radiation injury. When iodoacetamide was given with 25 R of irradiation, the percentage of eye anomalies increased from 6.7 to 19.6%. It was concluded that small quantities of iodoacetamide can cause an increase in radiation damages of rat embryos. The possibility of inhibition of postradiation repair mechanisms is discussed. (H.L.W.)

12119 THE BACKGROUND FOR MODIFICATION OF RADIATION DAMAGE BY SULPHUR COMPOUNDS. Hollaender, A.; Doherty, D. G. (Oak Ridge National Lab., Tenn.). pp 1-14 of Radiation Damage and Sulphydryl Compounds. Vienna; International Atomic Energy Agency (1969).

From Panel on Radiation Damage to the Biological Molecular Information System with Special Regard to the Role of Sh-Groups, Vienna, Austria. See CONF-681069.

The background for the use of sulfur compounds in modifying radiation damage is reviewed from a biological, chemical, and historical point of view. Special emphasis will be given to cytological as well as genetical studies. The literature could only be sampled, since the number of papers has exceeded 1000 in the last few years. The present status of the usefulness of some of the compounds, or combination of compounds, is emphasized. Finally, the problem of recovery from radiation damage is mentioned, and how this could be integrated with protection studies. (82 references) (auth)

12120 MECHANISM OF PROTECTION OF MACROMOLECULES AGAINST IONIZING RADIATION BY SULPHYDRYL AND OTHER PROTECTIVE AGENTS. Shapiro, B.; Kollmann, G. (Albert Einstein Medical Center, Philadelphia). pp 23-43 of Radiation Damage and Sulphydryl Compounds. Vienna; International Atomic Energy Agency (1969).

From Panel on Radiation Damage to the Biological Molecular Information System with Special Regard to the Role of Sh-Groups, Vienna, Austria. See CONF-681069.

Studies on the mechanism of radiation protection have been carried out on proteins in the form of enzymes and as an integral part of cell membranes, and on DNA in aqueous buffered solutions. Protective agents such as MEA, cystamine, GSH, GSSG, MEG, GED, ascorbic acid, and others have been used. The radiation ef-

fects were demonstrated by measurement of structural and functional changes in the proteins and structural changes in the DNA. Protection could be attributed to one or more of four mechanisms: random scavenging of radicals in the solution or suspending medium; scavenging of radicals formed on the target macromolecule; reducing the reactivity of radiosensitive groups on the target macromolecule to radicals produced in the solution or suspending medium; and localized radical scavenging at the surface of the target macromolecule. The first mechanism was demonstrated by observing the chemical change in agents that protected but were not bound to the target macromolecule. The second mechanism was demonstrated by observing the binding of agents to the protected macromolecule during irradiation. The third mechanism was demonstrated by observing mixed disulfide formation between protein sulfhydryl groups and protective agent sulfur prior to irradiation. The fourth mechanism was demonstrated by observing the correlation between the amount of binding of protective radical scavengers to DNA and the amount of protection. One or all of these mechanisms may be operative in vivo, and the design of new radiation protective agents should take all of them into consideration. (auth)

12121 STUDIES ON BIOCHEMICAL AND RADIOPROTECTIVE EFFECTS OF THIOLS AND DISULPHIDES AT THE SUBCELLULAR AND MOLECULAR LEVEL. Eldjarn, L.; Jellum, E. (Univ. of Oslo). pp 45-54 of Radiation Damage and Sulphydryl Compounds. Vienna; International Atomic Energy Agency (1969).

From Panel on Radiation Damage to the Biological Molecular Information System with Special Regard to the Role of Sh-Groups, Vienna, Austria. See CONF-681069.

The main objectives have been to throw light on the question: "Is chemical protection a matter of radiation chemistry or biochemistry?" The studies on the biological function, metabolism and integrity of mitochondria, nuclei, nucleic acids, and cellular membranes in the presence of thiols and disulfides are summarized. The penetration of disulfides through the mitochondrial membrane very much depend on the energy state of the particle. Only in low energy states may cystamine penetrate freely. NAD-dependent oxidations are then blocked due to leakage of pyridine nucleotides. CoA-dependent reactions are inhibited due to mixed disulfide formation with the co-enzyme. Oxidative phosphorylation is uncoupled. Reduction of the disulfide may under certain conditions take place by exchange reactions with lipoic acid. Thiols do not have these effects. Damage to cellular membranes is one effect of ionizing radiation. Toxic lipid peroxides may be important factors in this connection. Glutathione peroxidase in the presence of GSH very efficiently reduces the lipid peroxides to non-toxic hydroxy acids, which can readily be metabolized by the cells. Thiols and disulfides react with nuclear SH-enzymes, with thiol-containing histones and with DNA and RNA. The effect of a diaminodisulfide on the DNA-dependent synthesis of RNA may result in a net stimulation or net inhibition depending on the conditions. If radiochemistry is to play an important role, the question of how the protector becomes concentrated on the target molecules must be answered. Several ways of bringing about a local accumulation will be considered, with special emphasis on mixed disulfide formation with proteins and ionic binding to nucleic acids. Finally we will discuss the implications of these results in relation to the mechanism of radioprotective action. (auth)

12122 MECHANISM OF ACTION OF AMINOTHIOL RADIOPROTECTORS. Grant, G. A. (Defence Research Board, Ottawa). pp 95-101 of Radiation Damage and Sulphydryl Compounds. Vienna; International Atomic Energy Agency (1969).

From Panel on Radiation Damage to the Biological Molecular Information System with Special Regard to the Role of Sh-Groups, Vienna, Austria. See CONF-681069.

The mechanism of action of the radioprotective aminoalkylthiols is discussed considering new information on radiolysis and ESR studies of unsymmetrical disulfides and thiols. Modifications to the disulfide mechanism are proposed for the repair of the radiation lesion to the SH and S–S bonds. The variation of the Dose Reduction Factor with the chemical structure of the radioprotective agents is discussed in terms of the proposed modifications to the disulfide mechanism. (auth)

12123 ACTION OF SH-CONTAINING RADIOPROTECTORS ON NUCLEIC ACID METABOLISM. Goutier, R.; Baugnet-Mahieu, L. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg. Univ., Liege). pp 103-9 of Radiation Damage and Sulphydryl Compounds. Vienna; International Atomic Energy Agency (1969).

From Panel on Radiation Damage to the Biological Molecular Information System with Special Regard to the Role of Sh-Groups, Vienna, Austria. See CONF-681069.

The inhibiting action of SH-radioprotective drugs on nucleic acid synthesis and on mitotic activity is described. The importance of such inhibition in the phenomenon of radioprotection arises from the fact that it occurs during the period of radioprotection and that its intensity is allied to the radioprotective power. Involvement of a combination of the protector with DNA and of a protection of the DNA repair system is discussed. (auth)

12124 INTERPLAY BETWEEN NATURAL AND ARTIFICIAL RADIATION PROTECTION. Revesz, L. (Karolinska Institutet, Stockholm). pp 125-32 of Radiation Damage and Sulphydryl Compounds. Vienna; International Atomic Energy Agency (1969).

From Panel on Radiation Damage to the Biological Molecular Information System with Special Regard to the Role of Sh-Groups, Vienna, Austria. See CONF-681069.

The effect of treatment with radioprotective thiols on the natural radiation protection in mammalian cells is considered as reflected by the change in the amount of cellular sulfhydryl groups on the one hand, and the intracellular recovery from radiation injury on the other hand. Treatment with cysteamine, AET, or 5-mercaptopyridoxine raises the cellular glutathione level in excess of the amount which can be ascribed to a reduction of the oxidized glutathione present originally. 4-Mercaptopyridoxine, which in contrast to its structural analog lacks protective activity, raises the glutathione content to a lesser extent. The increase of the glutathione level is attributable to a release of glutathione from inherent mixed disulfides by an exchange reaction with the incorporated protector. The data can be interpreted as indicating that cellular mixed disulfides may function as a reservoir of intrinsic radioprotectors, and the mobilization of this reservoir may be a primary action of the incorporated, extrinsic protectors. When irradiation is performed with split doses under anoxic conditions, cells pretreated with cysteamine undergo partial recovery if incubated under aerobic conditions during the interval between the radiation exposures. Without pretreatment with cysteamine, anoxically irradiated cells fail to recover. The extent of recovery when exposure to radiation is made aerobically, is not influenced by cysteamine. The data are concordant in indicating that radiation injury remains reparable in cysteamine treated cells for a prolonged period before the injury becomes permanent. (auth)

12125 CHANGES IN SULPHYDRYL LEVELS INDUCED BY CYTOTOXIC AGENTS AND THE USE OF SUCH DATA FOR THE RAPID ASSESSMENT OF THE END RESULTS OF TUMOUR TREATMENT WITH CYTOTOXIC AGENTS. Calcutt, G. (Mount Vernon Hospital and the Radium Inst., Northwood, Eng.). pp 133-9 of Radiation Damage and Sulphydryl Compounds. Vienna; International Atomic Energy Agency (1969).

From Panel on Radiation Damage to the Biological Molecular Information System with Special Regard to the Role of Sh-Groups, Vienna, Austria. See CONF-681069.

Existing work on the measurement of both acid soluble and protein-bound sulfhydryl (-SH) levels of normal rat and mouse tissues after the application of a single dose of a cytotoxic agent has been surveyed. Apparent differences in body distribution of the drugs were noted. A consistent feature was a decided fall in acid-soluble SH levels within 24 hours of treatment. Protein-bound SH levels fluctuated irregularly about the values from untreated controls. Similar experiments have been carried out with the mouse tumors: sarcoma 180, plasma cell tumor ADJ/PC5, and ascites lymphoma NK/Ly. Acid soluble SH levels were regularly found to show little deviation from control values. The protein-bound SH values sometimes showed a peak within the first 12 hours after treatment, and consistently showed a peak 20 to 24 hours after treatment. This last peak appeared to vary in size according to the effectiveness of the agent against the tumor in question. It is suggested that this peak is the consequence of cell death and protein denaturation, with exposure of the SH groups. From this it is argued that measurements of SH levels before and about 24 hours after treatment with cytotoxic agents should give a measure of the effectiveness of the agent against a tumor. This has been tested experimentally by comparing changes in SH level 24 hours after treatment with the dose-response pattern obtained 10 to 14 days later and found to hold good for a variety of cytotoxic agents and the three tumors previously used. The possible applications of this finding are briefly surveyed and the further extension of this work with irradiation is considered. (auth)

12126 THE SHOCK PRODUCED BY LARGE DOSES OF RADIOPROTECTIVE SH AND SS SUBSTANCES. Bacq, Z. M.; Van Caneghem, P. (Univ., Liege). pp 141-7 of Radiation Damage and Sulphydryl Compounds. Vienna; International Atomic Energy Agency (1969).

From Panel on Radiation Damage to the Biological Molecular Information System with Special Regard to the Role of Sh-Groups, Vienna, Austria. See CONF-681069.

The condition of shock produced in the rat by injection of radio-

protective doses of MEA and cystamine are described. The discussion shows that probably the unspecific troubles seen in this condition of shock are of minor importance, and that certain rapidly occurring metabolic troubles, termed biochemical shock (i.e., inhibition of glucose metabolism and nucleic acid synthesis, contemporary to lesions of mitochondria and endoplasmic reticulum) are of much greater significance. Arguments in favor of this hypothesis are found in the analysis of the protection afforded by fluoroacetate and in the fact that, in bacterial growing cells, mercaptoethylamine may be removed (after contact with these cells) before irradiation and still induce protection. (auth)

12127 TOXIC AND RADIOPROTECTIVE EFFECTS OF AET. Dienstbier, Z. (Charles Univ., Prague); Pospisil, J.; Arient, M.; Kourilek, K. pp 149-67 of Radiation Damage and Sulphydryl Compounds. Vienna; International Atomic Energy Agency (1969).

From Panel on Radiation Damage to the Biological Molecular Information System with Special Regard to the Role of Sh-Groups, Vienna, Austria. See CONF-681069.

Some experiments made during study of the metabolism of deoxycytidine, the pentose cycle and several other biological systems after irradiation are reported. Experiments that deal with the biological and pharmacological effects of the radioprotective compound AET (S,2-aminoethylisothiuronium) in dogs, mice, and rats are stated in detail. AET in vivo and in vitro normalizes the transport of water and glucose in the intestine after irradiation; on the other hand it disturbs, very significantly, the cardiovascular system. This statement is underlined by the increase of transaminases in the blood. A number of biochemical changes that indicate a total biochemical shock were also found. AET does not inhibit the early post-irradiation changes in bone marrow, though in protected animals a more rapid regeneration, in the first place of erythropoiesis, was observed. (auth)

12128 PROTECTORS AND CHANGE IN THE RADIOSENSITIVE BIOCHEMICAL PROCESSES. Romantsev, E. F.; Filippovich, I. V.; Koshcheenko, N. N. (Inst. of Biophysics, Moscow). pp 169-75 of Radiation Damage and Sulphydryl Compounds. Vienna; International Atomic Energy Agency (1969). (In Russian).

From Panel on Radiation Damage to the Biological Molecular Information System with Special Regard to the Role of Sh-Groups, Vienna, Austria. See CONF-681069.

The injection of MEA and AET into rats causes a strong inhibition of thymidine phosphorylation in the thymus and spleen, but this inhibition is of a temporary nature. At the same time radiosensitizers of the penicillamine and mercaptoethanol type cause a marked reduction of thymidine phosphorylation. However, this effect is prolonged and remains for at least three hours after administration of the drug. In experiments with the hyaloplasm of thymus and spleen it is shown that MEA can be bound to proteins. MEA causes a rapid depression of RNA synthesis in the thymus nuclei (experiments with radioactive uracil). The significance of the temporary inhibition of DNA and RNA biosynthesis for an understanding of the mechanism of action of aminothiolic protectors is discussed. (auth)

12129 SOME ASPECTS OF RADIOPROTECTION BY CYSTEAMINE AND OF CYSTEINE METABOLISM AFTER IRRADIATING MICE. Streffer, C. (Radiologisches Institut, Freiburg i. B.). pp 177-83 of Radiation Damage and Sulphydryl Compounds. Vienna; International Atomic Energy Agency (1969).

From Panel on Radiation Damage to the Biological Molecular Information System with Special Regard to the Role of Sh-Groups, Vienna, Austria. See CONF-681069.

Measurements on the mortality of mice showed that MEA would also protect the animals after partial body irradiation. Comparative experiments with other radioprotectors supported the idea that MEA, 5-hydroxytryptamine, and TACE were acting through different mechanisms. This concept makes the combined application of such drugs very interesting. The ratio of lactate to pyruvate was decreased in the liver some hours after whole-body irradiation. As this equilibrium is also coupled to the ratio of sulfhydryl to disulfide groups via the pyridine nucleotides, it is suggested that radiation-induced changes take place in a way dependent on the latter equilibrium. Experimental evidence was given that supported the idea that the increased taurine excretion by mammals after irradiation originated not only due to a release of the amino acid from radiosensitive organs, but also from an enhanced biosynthesis of taurine. (auth)

12130 A STUDY OF RADIOPROTECTION IN HYMENOLEPIS MICROSTOMA. Withrow, Ruth Hammer. Knoxville, Tenn.; Univ. of Tennessee (1969). 76p.

Thesis.

The primary objective of this investigation was to study the protective effect of anoxia and the sulfhydryl agent, S-2-aminoethylisothiuronium (AET), on irradiated Hymenolepis microstoma. Seven-day old tapeworms were treated with nitrogen or AET while being subjected in vitro to single doses of 2,500 R, 500 R, or 10,000 R of x rays. These worms were then transplanted into recipient mice. Control worms were treated similarly but did not receive any radioprotective agent. The hosts were sacrificed after 7 days and the worms collected for study. Anomalies to the testes and sterility were the criteria of radiation damage that were studied. There is an apparent lack of irradiation effect at 10,000 R on testes anomalies due to the concealment of damage to the testes by sterility, which is almost total at 10,000 R. Therefore, testes anomalies at this irradiation level are discussed only in terms of the high sterility value. For this reason sterility is the better measure of irradiation damage and protection. The following results are discussed: toxicity of AET to the tapeworms limited the drug concentration to 0.1 M; a concentration of 0.1 M AET shows no protective influence at 2,500 R; the difference in sterility for the AET-treated worms and the controls at the two highest doses of irradiation is highly significant; anoxia shows a protective effect on both anomalies to the testes and sterility at all irradiation levels. It is concluded that under the experimental conditions described within, anoxia exhibits greater radioprotection to the cestode, Hymenolepis microstoma, than the sulfhydryl compound, AET. Plausible explanations for the differences in the radioprotective activity of AET and nitrogen treatment on this system are discussed. (Disser. Abstr.)

12131 STATE OF THE PROGENY OF LETHALLY IRRADIATED ANIMALS TREATED WITH PROPHYLACTIC AND THERAPEUTIC DRUGS. Dimitrov, L.; Nedyalkova, M. (Research Inst. on Haematology and Blood Transfusion, Sofia). Compt. Rend. Acad. Bulg. Sci.; 22: 839-42(1969).

Progeny of rats that had survived lethal irradiation following treatment with AET, MEA, serotonin, bone marrow, antibiotics, and vitamins were examined for body weight, number of cells in peripheral blood, DNA and protein metabolism, and immunologic reactions. The highest percentage of births and the most numerous progeny were observed among animals treated with all of the radioprotective agents. No progeny appeared at all in rats treated with radioprotective drugs alone. A considerable number of the newborn died during the 30 days after birth, the highest mortality rate being in the group treated with drugs and antibiotics, and the lowest being in the group treated with all radioprotective agents. (H.L.W.)

12132 ON THE RADIOPROTECTIVE EFFECT OF AET ON THE SMALL INTESTINE EPITHELIUM OF IRRADIATED MICE. I. EFFECT ON THE PROTECTOR ON THE AMOUNT OF CRYPT CELL POPULATION, MITOTIC ACTIVITY, AND THE RATE OF CHROMOSOME ABERRATIONS. Barkan, R. S.; Kononenko, A. M. (Central Research Inst. of Roentgenology and Radiology, Leningrad). Tsitologiya; 11: 1419-26(Nov 1969). (In Russian).

Male mice, weighing 20 to 23 gm, were exposed to 400, 700, 900, and 1200 rad of a single x irradiation. One half of these were protected with aminoethylisothiuronium (AET), whereas the other was used as a control. Intestinal epithelium of mice was examined within 72 hours following irradiation; several cytological aspects were observed: the total number of cells per crypt, the mitotic index, and the percentage of cells with chromosome breaks. Squash preparations of individual whole crypts were prepared. No essential effect of AET on the mitotic activity of irradiated epithelium was observed. AET exerted no influence on the size of cell population in the course of crypt devastation, however, it markedly accelerated the increase in crypt cell number during their recovery. This effect may be due to a smaller number of cells with chromosome breaks present in epithelium of protected mice. The rate of chromosome aberrations was investigated starting from the first mitosis following irradiation (anaphase analysis). A selectivity in the protective effect of AET on different stages of cell cycle was discovered. A protective influence is suggested to be exerted on cells irradiated in g_1 or in early S stage, rather than in g_2 in the late S stage. (auth)

Radiation Sickness and Injuries

Refer also to abstract 12309.

12133 RESTORATION OF RADIATION-INDUCED DAMAGE RELATED TO THE CELL CYCLE. Petrovic, D.; Ferle-Vidovic, Ana (Inst. Ruder Boskovic, Zagreb). pp 81-9 of Effects of Radiation on Cellular Proliferation and Differentiation. Vienna; International Atomic Energy Agency (1968).

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco. See STI/PUB-186; CONF-680413.

A restorative effect of DNA and its precursors in asynchronously growing L-cells after x irradiation was previously found. The fact that the precursors were active only if all four of them were added in the form of an equimolar solution, as well as some other data, indicated that such treatment might support certain repair processes in the damaged metabolism of nucleic acids. To obtain more information on this problem, synchronized populations of L-cells were irradiated at different stages of the cell cycle with 500 R of x rays and then treated with either highly polymerized DNA or with nucleotides or nucleosides. The survival of the treated and untreated cells was then calculated and compared. It was found that the cells were over ten times more sensitive in the DNA-synthetic (S) period than in the presynthetic (G_1) period. The restorative effect of all three materials was related to the S period. The highly polymerized DNA and the deoxyribonucleosides were much more effective than the deoxyribonucleotides. The results indicate that the influence of small molecules and the role they play in the damaged metabolism of nucleic acids could be of considerable importance in the mechanism of the restorative effect produced by nucleic-acid treatment. (auth)

Radiodiagnosis

Refer also to abstracts 11453, 11765, 11773, 11774, 11917, 11920, 12073, 12078, and 12089.

12134 (LIB/Trans-232) ^{99m}Tc HUMAN SERUM ALBUMIN IN COLLOIDAL FORM FOR THE SCINTIGRAPHY OF THE LIVER. Kort, Walter. Translated by U. Engelbert (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from Strahlentherapie; 137: 420-3(Apr. 1969). 7p. Dep. CFSTI (U.S. Sales Only).

Methods are described for the preparation of ^{99}Tc-labeled colloids of human serum albumin with a particle size that assures rapid uptake by the liver. Applications for scintillation scanning of the liver are discussed. The use of 1000 μCi of ^{99}Tc-albumin colloids generates a radiation dose of 0.2 rads in the liver region. It has the advantage that it is metabolized quickly, resulting in an effective half-life in the liver of approximately four hours. (C.H.)

12135 INTERFERENCE OF SCALP AND SKULL WITH EXTERNAL MEASUREMENTS OF BRAIN ISOTOPE CONTENT. PART 2. ABSORPTION BY SKULL OF GAMMA RADIATION ORIGINATING IN BRAIN. Oldendorf, William H.; Iisaka Youichi (Wadsworth Hospital, Los Angeles. Univ. of California, Los Angeles). J. Nucl. Med.; 10: 184-7(Apr 1969).

The broad-beam absorption of thick and thin wet human skull regions was measured. Isotope sources producing a range of photon energies were used. The absorption of gamma radiation rises sharply below about 100 keV. The radiation of ^{133}Xe is 20 to 30% absorbed and of ^{125}I is 60 to 80% absorbed. In external measurements of brain in which scalp contains isotope, skull absorption should be considered, particularly when counting photons less than 100 keV. (auth)

12136 COMPARATIVE EVALUATION OF PULMONARY FUNCTION BY ISOTOPE IMAGING, ANGIOPNEUMOGRAPHY, AND DIFFERENTIAL BRONCHOSPIROMETRY. Bernadou, J.; Beck, C.; Freour, P.; Blanquet, P. (Centre Xavier-Arnozan, Pessac, France. Hopital Saint-Andre, Bordeaux). J. Nucl. Med.; 10: 174-6(Apr 1969).

Scintigraphy using ^{131}I-IHSA macroaggregate is a particularly interesting technique for measuring pulmonary perfusion in light of its nontraumatic nature, the ease with which it can be executed and the existing modern methods of quantitating data. It seems capable of producing reliable information for two categories of problems. For those patients exhibiting localized disease for which excision is envisaged, the method lets one evaluate the proportion of perfusion to be suppressed by surgery. Results have often been prime factors in deciding the type of therapy to be adopted. Also, the isotope technique can be used to explain the physiopathology of certain respiratory insufficiencies when one combines ventilation and perfusion scintigraphy. Thus the mechanism of oxygen desaturation is obvious when isotopic perfusion studies are normal and anomalies are revealed by ventilation scintigraphy in the form of inactive zones. It is emphasized that the ease of execution of the isotopic methods described makes them particularly applicable to post-therapy surveillance. (auth)

12137 A DOUBLE-ISOTOPE APPROACH TO THE ESTIMATION OF DEPTH OF SOURCE IN SCINTIGRAPHIC MATRICES. Tauxe, W. Newlon; Dolan, Charles T. (Mayo Clinic, Rochester, Minn. Mayo Foundation, Rochester, Minn.). J. Nucl. Med.; 10: 188-91(Apr 1969).

An approach to three-dimensional scanning by a double-isotope technique is presented in which computer-processing of data is used. (auth)

12138 WHOLE-BODY SCANNING OF ^{59}Fe FOR EVALUATING BODY DISTRIBUTION OF ERYTHROPOIETIC MARROW, SPLENIC SEQUESTRATION OF RED CELLS AND HEPATIC DEPOSITION OF IRON. Ronai, Peter; Winchell, H. S.; Anger, H. O.; Lawrence, J. H. (Univ. of California, Berkeley). J. Nucl. Med.; 10: 469-74(Jul 1969).

A simple, rapid-imaging whole-body scanner used with ^{59}Fe was valuable in visualizing marrow distribution, determining sites of red-cell sequestration, and evaluating hepatic storage-iron deposition. During the course of radioiron kinetics studies, whole-body scanning served as a useful check on the external-monitoring activity curves, the accuracy of which depended on probe positioning and zero-time extrapolation. Such dependence occasionally resulted in ambiguities that were resolved with the whole-body scan. (auth)

12139 SOME DIFFERENCES BETWEEN BONE SCANS MADE WITH ^{87m}Sr AND ^{85}Sr. Charkes, N. David (Temple Univ., Philadelphia. Temple Univ. Hospital, Philadelphia). J. Nucl. Med.; 10: 491-4(Jul 1969).

Bone scans made with ^{87m}Sr are not always identical to those made with ^{85}Sr. Areas of increased blood flow may simulate bone tumors on ^{87m}Sr scans (false-positive scan) and known bone tumors may be buried in the high body background shortly after isotope administration, giving rise to false-negative scans. These points are brought out by two cases. The ^{85}Sr scan performed 48 hr after injection is not subject to these interpretive errors and may also become more positive with time as a result of progressive increment in strontium deposition. (auth)

12140 NECK EXTRATHYROIDAL ACTIVITY OF ^{99m}Tc-PERTECHNETATE. Shimmins, J.; Hilditch, T. E.; Harden, R. McG.; Alexander, W. D. (Western Infirmary, Glasgow). J. Nucl. Med.; 10: 483-6(Jul 1969).

The contribution of neck extrathyroidal activity of ^{99m}Tc-pertechnetate in the field of view of the standard IAEA thyroid collimator was measured in 12 patients using a scanning method. The mean extrathyroidal activity was 6.7% of the whole-body extrathyroidal activity at 3 min after intravenous administration and 5.7% of the whole-body extrathyroidal activity at 15 min after administration. These values were compared with measurements of the extrathyroidal activity of iodide, and it was found that the extrathyroidal space of iodide was 1.41 times the extrathyroidal space of pertechnetate 15 min after isotope administration. Equations were formulated from these data to calculate thyroid pertechnetate uptake at 3 min and 20 min after intravenous pertechnetate administration. (auth)

12141 SPLEEN SCANNING WITH RED CELLS SIMULTANEOUSLY ^{51}Cr-TAGGED AND HEAT-TREATED. Kyle, Ralph W.; Gotshall, Elizabeth; Johnston, Gerald S. (Walter Reed General Hospital, Washington, D. C.). J. Nucl. Med.; 10: 480-2(Jul 1969).

The role of splenic photoscans is well documented by a number of workers, but has not been extensively used because of the time required for preparation and the lack of reproducible results. A rapid method for simultaneously labeling with ^{51}Cr and heat-denaturing red cells and subsequent scanning in a total elapsed time of less than 1 hr is described. (auth)

12142 BIOLOGICAL BEHAVIOR OF $K^{56}MnO_4$: ITS ACCUMULATION IN NORMAL TISSUES AND PATHOLOGICAL BRAIN. Roda, J. E.; Soloway, A. H.; Benda, P.; Sweet, W. H. (Massachusetts General Hospital, Boston). J. Nucl. Med.; 10: 205-8 (May 1969).

Radioactive permanganate as ^{56}Mn has been found to concentrate in lung, liver, kidney and cerebral lesions at levels that depend on the route of administration. Consequently, radioactive permanganate may have potential as a scanning agent for these organs. Moreover, its rapid elimination in the bile may permit its use for determining pathology in the gallbladder. (auth)

12143 DEMONSTRATION OF SPINAL TUMORS WITH INTRAVENOUSLY INJECTED ^{99m}Tc-PERTECHNETATE: A NEW DIAGNOSTIC TECHNIQUE. Fazio, C.; Agnoli, A.; Bava, G. L.; Bozzao, L.; Fieschi, C. (Univ., Genoa). J. Nucl. Med.; 10: 508-10 (Jul 1969).

A new technique for radioisotope scanning of the spinal canal with intravenous ^{99m}Tc is proposed. The method differs from myeloscintigraphy after intrathecal injection of tracer. Results obtained in 10 normal, healthy subjects and in 10 patients with vertebral, epidural or dural lesions and in two cases with intramedullary tumors are reported. While the lesions of the spinal canal were correctly diagnosed, the intramedullary tumors were

missed. The new technique is valuable as a nontraumatic preoperative method and might prove useful also as a routine diagnostic tool. (auth)

12144 NONDESTRUCTIVE METHOD FOR MEASURING CEREBRAL HEMISPHERIC BLOOD FLOW: A PRELIMINARY REPORT USING A GAMMA CAMERA. Jackson, George L.; Blosser, Nancy (Harrisburg Hospital, Pa. Hahnemann Medical Center, Philadelphia). J. Nucl. Med.; 10: 501-7(Jul 1969).

Studies of cerebral hemispheric blood flow are reported. These were made possible by: High concentration technetium and the detector array and electronic assembly of the Digital Autofluoroscope. This permitted repeated study and selection of precise arrays for integration. Results to date suggest that the absolute height of the peak of the hemispheric curve bears a direct relation to the volume of blood flow. There is a significantly lower hemispheric count rate in many patients with cerebral vascular disease. Present data of time sequences are not sufficient to permit definite conclusions but suggest that meaningful data will be obtained. (auth

12145 DIAGNOSIS OF PERICARDIAL EFFUSION BY RADIOISOTOPIC ANGIOCARDIOGRAPHY. Kriss, Joseph P. (Stanford Univ. School of Medicine, Calif.). J. Nucl. Med.; 10: 233-41 (May 1969).

A technique of radioisotopic angiocardiography following intravenous injection of ^{99m}Tc-pertechnetate has been described and its application shown in six consecutive patients with pericardial effusion. The method is simple to perform, is clinically useful and offers a number of important advantages over conventional heart-scanning techniques. These advantages include greater speed, flexibility in patient position, visual delineation of both intracardiac blood pool and pericardial sac, assessment of the speed of circulation, elimination of the need for iodine blockade of the thyroid gland and opportunity to repeat studies at frequent intervals. (auth)

12146 DIAGNOSIS OF SPONDYLITIS BY EXTERNAL ^{85}Sr COUNTING: A COMPARISON OF ANALYTIC PROCEDURES. Lindberg, Lars (Univ. of Lund, Malmoe, Sweden); Schwartz, Melvin S. J. Nucl. Med.; 10: 213-18(May 1969).

A method to assess with the ^{85}Sr external counting whether an infectious spondylitis is active or healed has been described previously. A statistical analysis of four different possibilities to assess the results of the countings is presented. (auth)

12147 TAPE RECORDING OF DUAL-CHANNEL ENERGY-MODULATED COLOR SCANNING. Ben-Porath, Moshe; Clayton, Glenn D.; Kaplan, Ervin (Loyola Univ. Stritch School of Medicine. Univ. of Illinois Coll. of Medicine, Chicago). J. Nucl. Med.; 10: 155-9(May 1969).

The use of a four-channel tape-recording display system is described for multi-isotope scanning. It has been shown that this technique provides a superior display of the scanning information, permits the analysis of the scan at various contrast settings and may aid in the visualization of brain lesions. It has also been shown that ^{75}Se-selenomethionine concentrates sufficiently in the myocardium to permit good visualization of this organ. The clinical aspects of this technique will be described in a future paper. (auth)

12148 LOCALIZATION OF ^{113m}In-CHELATES COMPARED WITH ^{99m}Tc-SODIUM PERTECHNETATE IN EXPERIMENTAL CEREBRAL LESIONS. Burdine, John A. Jr.; Waltz, Thomas A.; Matsen, III, Frederick A.; Rapp, Fred (Baylor Univ. Coll. of Medicine, Houston, Tex.). J. Nucl. Med.; 10: 290-3(June 1969).

A series of ^{113m}In-tagged chelates was compared with ^{99m}Tc-sodium pertechnetate for degree of localization in experimental brain lesions of dogs and hamsters. The lesion-to-brain ratios obtained when the two radionuclides were given simultaneously were consistently higher for indium-EDTA and DTPA. Because the rapid disappearance of these compounds from the blood reduces background contribution to total activity, they may prove to be the agents of choice for brain imaging. (auth)

12149 THYROID-UPTAKE STUDIES USING ^{132}I. Levy, Bernard S. (Massachusetts General Hospital, Boston. Harvard Medical School, Boston). J. Nucl. Med.; 10: 286-9(June 1969).

There are a number of clinical situations in which ^{132}I can be substituted for ^{131}I in radioiodine thyroid-uptake determinations. Serial determinations are possible using ^{132}I with a significant reduction in the absorbed thyroid radiation compared with similar administered quantities of ^{131}I. Repeat uptake values are reproducible and correlate well with other measurements of thyroid function in normal and hyperthyroid individuals. No special equipment is required so that ordinarily available counting equipment can be used. (auth)

12150 DYNAMIC CLINICAL STUDIES WITH RADIOISOTOPES AND THE SCINTILLATION CAMERA. IV. ^{99m}Tc-SODIUM PERTECHNETATE CARDIAC BLOOD-FLOW STUDIES. Burke, Gerald; Haiko, Arlene; Goldberg, David (Michael Reese Hospital and Medical Center, Chicago). J. Nucl. Med.; 10: 270-80(June 1969).

The scintillation camera has been used for dynamic studies of cardiopulmonary blood flow with ^{99m}Tc-sodium pertechnetate. Visualization of the cardiac chambers achieved with this method compares favorably with that obtained on conventional angiocardiography. The technique has been found of value in determining relative cardiac chamber size, detection of intracardiac shunts and demonstration of pericardial effusions as well as in the diagnosis of superior vena caval syndrome. Determinations of central mean transit time and its arterial and venous subdivisions from inspection of the scintiphoto sequence yield data entirely analogous to those obtained by the more tedious mathematical analysis of dual-probe radiopulmonary cardiogram curves in normal subjects and patients with cardiac disease. Cardiac blood-flow study with the scintillation camera is without hazard to the patient and is of significant diagnostic value in a variety of cardiac disorders. (auth)

12151 ESTIMATION OF THYROID UPTAKE OF ^{131}I FROM DIGITIZED SCINTISCAN MATRICES. Tauxe, W. Newlon (Mayo Clinic, Rochester, Minn. Mayo Foundation, Rochester, Minn.). J. Nucl. Med.; 10: 258-60(Jun 1969).

The application of digital-computer processing of scintiscan matrices to the calculation of thyroid-uptake values is described. This technique lets one estimate ^{131}I thyroid uptake from the data produced by scintiscanning. (auth)

12152 INTRA-ARTERIAL ^{131}I-MACROAGGREGATED ALBUMIN TO DEFINE INTRAHEPATIC TUMORS: A POSSIBLE METHOD OF QUANTITATING TUMOR RESPONSE TO THERAPY. Blank, Richard J.; Tyson, Ian B. (Univ. of Wisconsin, Madison). J. Nucl. Med.; 10: 514-6(Jul 1969).

Twelve patients being infused with chemotherapeutic agents through hepatic arterial catheters were injected with ^{131}I-macroaggregated albumin. Scans using this method are presented and suggest that positive images of hepatic abnormalities are produced. The method may be useful for more accurate evaluation of chemotherapy in patients being infused for hepatic metastatic disease. Further evaluation of these preliminary findings is currently under study both in patients and in animals. (auth)

12153 DIGITAL-COMPUTER INTERPRETATION OF RADIOISOTOPE DISTRIBUTION PATTERNS. Sprawls, Perry Jr. (Emory Univ., Atlanta. Clemson Univ., S. C.). J. Nucl. Med.; 10: 618-20(Oct 1969).

The pattern of radioisotope distribution in thyroid scans was reduced to 18 numerical parameters that can be used for computer classification of the pattern. The three characteristics, dispersion, skewness, and kurtosis, of each of the six profiles (planes) give the total of 18 numerical parameters. A computer may then evaluate a particular distribution pattern by determining if all of the 18 describing characteristics are within the normal range. In 57 of 60 samples, the computer's interpretation as to normal or not normal agreed with that of a physician. (C.O.)

12154 COMBINED DIAGNOSTIC APPROACH OF HEPATIC SCANNING AND CELIAC ANGIOGRAPHY IN THE INVESTIGATION OF LIVER DISEASE. Freeman, Leonard M.; Bernstein, Robert G.; Katz, Monique C.; Derman, Arnold; Meng, Chien-hsing (Yeshiva Univ., New York). J. Nucl. Med.; 10: 628-32(Oct 1969).

Liver scanning and celiac angiography serve as complementary diagnostic procedures in the study of liver disease. The simple, rapid, and innocuous liver scan generally serves as an excellent screening procedure to help localize the disease process. The more refined celiac angiogram offers a means of distinguishing between various types of defects seen on the scan. Lesions beyond the resolution of the scan (less than 2 cm) are occasionally suspected on the angiogram whereas the scan is sometimes more successful in detecting peripheral lesions. The preoperative angiogram is of particular value in outlining the vascular architecture of the liver. The scan provides a simple means of locating suitable biopsy sites as well as following the course of a patient's disease process at regular intervals if necessary. (auth)

12155 NEW PATTERNS OF ABNORMAL PULMONARY PERFUSION ASSOCIATED WITH PULMONARY EMBOLI. I. SCINTIGRAPHIC MANIFESTATIONS. Eaton, S. Boyd; James, A. Everette; Greene, Reginald E.; Lyons, Joseph H.; Potsaid, Majic S.; Fleischner, Felix G. (Harvard Medical School, Boston. Massachusetts General Hospital, Boston). J. Nucl. Med.; 10: 571-4(Sep 1969).

A scintigraphic pattern consisting of peripheral pulmonary hypoperfusion is presented. This curvilinear or circumferential zone of decreased radioactivity is usually best recognized along the interlobar fissures. It is thought that the observed pattern results from numerous microemboli lodging in the small axial arteries at the lung periphery. In cases where multiple views, especially lateral projections, are obtained with the gamma camera, it is almost as common as the generally accepted discrete local defect. (auth)

12156 LONGITUDINAL TOMOGRAPHIC RADIOISOTOPIC IMAGING WITH A SCINTILLATION CAMERA: THEORETICAL CONSIDERATIONS OF A NEW METHOD. McAfee, John G. (State Univ. of New York, Syracuse); Mozley, James M.; Stabler, Edward P. J. Nucl. Med.; 10: 654-9(Oct 1969).

A system for gamma-ray tomography is proposed that appears to possess the following desirable features: It possesses a high efficiency of detection equal to the Anger camera when used in its conventional stationary mode. It possesses the capability of accumulating the necessary counting-rate information required for the image formation within a practical time limit of approximately 10 min. The counting-rate information may be processed digitally for the formation of a tomographic image at any desired depth within a few minutes. By the selective summation of counting-rate information for a given depth, the ability to detect small volumes of increased or decreased activity within a large volume of radioactivity should be greatly enhanced. The proposed instrument system contains, for the most part, components that have already been developed, including the Anger camera, digital magnetic tape storage, and a small digital computer. The latter component is already being used in several laboratories for the processing of time-sequence studies performed on the Anger camera. The fabrication of the special collimator and mechanical drive for the detector head should be relatively simple. It is also feasible to produce the tomographic images by analog tape recording and analog computer processing using the principles described above. The analog system would be lower in cost but the computational flexibility would be limited in comparison to the digital system. (auth)

12157 ^{113m}In-LABELED COMPOUND FOR LIVER AND SPLEEN STUDIES. Colombetti, Lelio G.; Goodwin, David A.; Hermanson, Russell (Stanford School of Medicine, Palo Alto, Calif.). J. Nucl. Med.; 10: 597-602(Sep 1969).

A method of preparation of ^{113m}In-labeled particles for combined liver and spleen studies is described. The splenic uptake of ^{113m}In-colloid has been increased by increasing the particle size by adding iron as carrier. The method used to prepare these Fe-^{113m}In particles for liver and spleen studies has proved to be simple, rapid, and clinically useful. Excellent quality scintiphotographs and scintiscans were obtained. It was possible to visualize the spleen in all patients studied with the exception of two who had undergone splenectomy. Because of the frequent association of hepatic and splenic diseases, it is an advantage to examine both organs at the same time. Because of the physical properties of ^{113m}In, it is possible to administer millicurie doses to the patients, which result in larger counting rates, more rapid scans, and greater diagnostic accuracy. (auth)

12158 TISSUE VASCULARITY IN POSITIVE AND NEGATIVE BRAIN SCANS. Cohn, Howard J.; Soiderer, Manfred H. (Wayne County General Hospital, Eloise, Mich. Univ. of Michigan, Ann Arbor). J. Nucl. Med.; 10: 553-7(Aug 1969).

Alteration of the normal blood-brain barrier is assumed to be responsible for visualization of intracranial lesions on the brain scan. The specific factors are not known. To evaluate the importance of tissue vascularity as a factor, 107 brain scans with histopathological verification were studied. The tissue vascularity was graded by an independent observer without knowledge of the brain-scan interpretation. The tissue vascularity was then compared with the clinical brain-scan readings. Chi-square analysis of these data was interpreted as indicating a correlation of the degree of vascularity of the lesions with visualization on brain scan. Of the five blood vessel tumors and vascular malformations, however, two were equivocal on brain scan and three were not visualized at all. This suggests that in addition to the degree of vascularity the maturity of the vessels and the relative metabolic activity of the tissue are factors in visualization although the visualization of these lesions may be by a different mechanism. (auth)

12159 COMPUTER COMPATIBLE MICROFILMING SYSTEM FOR NUCLEAR MEDICINE. Freedman, Gerald S. (Yale Univ. School of Medicine, New Haven). J. Nucl. Med.; 10: 562-3 (Aug 1969).

A data processing and retrieval system is proposed in which a 35-mm microfilm aperture is inserted into a standard IBM card. The unused 55 columns on the IBM card are free for punched information. The microfilm chip can include photoscans and printed material such as the scan requisition and final report. A method for viewing the microfilm card and for producing prints of this information is also presented. While scans can be microfilmed and stored in this manner, attempts to extend this to include radiographs have been less successful. (auth)

12160 KIDNEY VISUALIZATION WITH ^{131}I-ORTHO-IODOHIPPURATE IN PATIENTS WITH RENAL INSUFFICIENCY. Freeman, Leonard M.; Goldman, Stanford M.; Shaw, Richard K.; Blaufox, M. Donald (Yeshiva Univ., New York). J. Nucl. Med.; 10: 545-9(Aug 1969).

Scans made with ^{131}I-ortho-iodohippurate successfully visualized the kidneys in 18 of 19 patients with blood urea nitrogen and plasma creatinine concentrations ranging from 62 to 146 and 3.5 to 17.2 mg/100 ml, respectively. Intravenous urography and ^{197}Hg-chlormerodrin renal scanning were inadequate in these patients when attempted at the time of the hippuran scans. The ^{131}I-ortho-iodohippurate is excreted slowly by the failing kidney. The prolonged transit time of this radiopharmaceutical in the diseased kidney allows sufficient time for adequate scanning studies with conventional rectilinear scanning equipment. The method is rapid, safe and easy to perform. It is recommended as a potentially useful means of evaluating kidney size in the severely azotemic patient. It provides an indirect assessment of the duration of the renal disease. At this time the method does not permit differentiation of obstructive from nonobstructive kidney disease. (auth)

12161 RENOGRAMS COMPARED WITH UROGRAMS, ARTERIOGRAMS, AND FUNCTION STUDIES. Hamby, William M.; Miller, Edwin B.; Kaplan, Ervin (Veterans Administration Hospital, Hines, Ill. Univ. of Illinois Coll. of Medicine, Chicago). J. Nucl. Med.; 10: 603-6(Sep 1969).

Forty-seven hypertensive patients were studied with renograms, excretory urograms, unilateral renal function studies, and renal arteriograms. Renograms failed to identify two patients with significant unilateral renal artery stenosis. All patients with significant unilateral renal vascular disease were identified by combining the results of the timed excretory urograms with the renograms. The study suggests that this combination of procedures is an adequate screening technique for the presence of unilateral renal vascular disease. (auth)

12162 FLUORESCENCE DETECTION: APPLICATION TO THE STUDY OF CEREBRAL BLOOD FLOW. Hoffer, Paul B.; Polcyn, Robert E.; Moody, Robert; Lowe, Henry J.; Gottschalk, Alexander (Univ. of Chicago. Argonne Cancer Research Hospital, Chicago). J. Nucl. Med.; 10: 651-3(Oct 1969).

Two methods of combining a nonradioactive tracer and fluorescent detector for the determination of cerebral transit time and blood flow are demonstrated. Since both methods detect fluorescent activity exclusively in a predetermined volume of brain, it is possible to avoid recording tracer activity from overlying bone and soft tissue. The need for selective arterial injection can be eliminated by using the stable xenon clearance technique. The only drawback is the expense of the xenon gas. (auth)

12163 DETECTION AND DETERMINATION OF LEFT-RIGHT SHUNTS BY ISOTOPE DILUTION CURVES. Di Matteo, J. (Hopital Necker, Paris); Picard, R.; Vacheron, A.; Cucumel, M.; Bousquet, O.; Kellershohn, C.; de Vernejoul, P. Ann. Med. Interne; 120: 199-206(Mar 1969). (In French).

A method for detection of left-right cardiac shunts employing ^{132}I and ^{137m}Ba was compared for accuracy with cardiac catheterization results in 158 patients. The radioisotope method is based on registration of the intracardiac isotope dilution curve by an external precordial scintillation detector. Iodine-132, with a half-life of 2.26 hr, was first used, then replaced by ^{137m}Ba, with a shorter half-life period (2.26 min). This permitted safe injection of doses up to 10 mCi ^{137m}Ba. The radiation dose received by the patient was less than that encountered in thoracic fluoroscopy, but the method is contraindicated during pregnancy. The normal scanning record shows two peaks, one for passage of the isotope into the right heart and the other for the left heart. The intervening minimum represents the pulmonary circulation. From changes in the maxima the severity of the left-right cardiac shunt can be calculated. How this may be done is explained. This radioisotope technique is as accurate as results of cardiac catheterization. (BBB)

12164 EVALUATION OF SPLENIC FUNCTION USING ^{197}Hg-MERCURIHYDROXYPROPANE. Loken, Merle K.; Bugby, Robert D.; Lowman, James T. (Univ. of Minnesota, Minneapolis). J. Nucl. Med.; 10: 615-7(Oct 1969).

Function studies and scans were performed on 56 patients. Most studies used ^{197}Hg-labeled 1-bromomercuri-2-hydroxypropane

(MHP). Fifteen patients were also studied by the ^{51}Cr red-cell sequestration technique. The splenic curves obtained from continuous monitoring after the intravenous injection of MHP-labeled red cells followed definite and reproducible patterns. Data suggested that the capacity of the spleen to sequester red cells and its scan appearance can be readily obtained by using MHP. A table gives the correlation of overall clinical evaluation and data on splenic sequestration of erythrocytes using ^{197}Hg-MHP and ^{51}Cr-labeled cells. A major advantage of the ^{197}Hg method is the much shorter time required. (C.O.)

12165 PYRAMIDAL LOBE IN THYROID IMAGING. Izenstark, J. L.; Forsaith, A. L.; Horwitz, N. H. (William Beaumont Hospital, Royal Oak, Mich.). J. Nucl. Med.; 10: 519-24(Aug 1969).

With careful techniques and adequate radioactivity, the pyramidal lobe of the thyroid gland is visualized in approximately 35% of all patients presenting for thyroid scans. Postoperative and post ^{131}I-treated patients, hyperthyroid patients, and patients with large glands show a higher incidence of pyramidal lobes, approaching 50 to 60%. The pyramidal lobe may present as a hypertrophied-hyperplastic structure in posttherapy patients. Its recognition and proper management may spare the patient anxiety and surgery. Oblique views can help to define the pyramidal lobe since the lobe presents anterior to the main thyroid gland and is very close to the outline of the neck. Any palpable masses should be correlated with the image while the patient is under the scanner. Using the technical parameters described in this study, no significant difference was found between the Spintharicon and the rectilinear scanner in detecting pyramidal lobes. (auth)

12166 PROCESSING RADIOISOTOPE SCANS. Pizer, Stephen M. (Univ. of North Carolina, Chapel Hill. Massachusetts General Hospital, Boston); Vetter, Henri G. J. Nucl. Med.; 10: 150-4(Apr 1969).

Variable spatial averaging gives quite superior results to fixed spatial averaging. It is also superior to variable smearing. Dot shifting can measurably improve the sharpness of a scan. Initial results of processing a few dozen real scans bear out these conclusions. Figures showing an unprocessed scan, its best fixed spatial averaging and its variable spatial averaging, respectively, are representative of the effect observed. (auth)

12167 TAPE RECORDING OF DUAL-CHANNEL ENERGY-MODULATED COLOR SCANNING. Ben-Porath, Moshe; Clayton, Glenn D.; Kaplan, Ervin (Veterans Administration Hospital, Hines, Ill. Loyola Univ. Stritch School of Medicine, Hines, Ill. Univ. of Illinois Coll. of Medicine, Chicago). J. Nucl. Med.; 10: 155-9(Apr 1969).

The use of a four-channel tape-recording display system is described for multi-isotope scanning. It has been shown that this technique provides a superior display of the scanning information, permits the analysis of the scan at various contrast settings and may aid in the visualization of brain lesions. It has also been shown that ^{75}Se-selenomethionine concentrates sufficiently in the myocardium to permit good visualization of this organ. The clinical aspects of this technique will be described in a future paper. (auth)

12168 REGIONAL CEREBRAL BLOOD FLOW: A COMPARISON OF 8-DETECTOR AND 16-DETECTOR INSTRUMENTATION. Paulson, O. B.; Cronqvist, S.; Risberg, J.; Jeppesen, F. I. (Bispebjerg Hospital, Copenhagen. University Hospital, Lund, Sweden). J. Nucl. Med.; 10: 164-73(Apr 1969).

An 8-detector and a 16-detector system for measuring regional cerebral blood flow (rCBF) using a slug injection of ^{133}Xe into the internal carotid artery have been compared in a group of ten patients with focal cerebral disease. The results have been analyzed with special regard to the abnormalities encountered in the first two minutes of the clearance curves. These abnormalities are described in detail (shunt peak, tissue peak, abnormal initial slope index). The 10-min flow values ($rCBF_{10}$) have also been calculated but were found to give less information than the analysis of the first 2 min of the clearance curves. Focal abnormalities were found with greater frequency and much better resolution, and more detailed information was obtained using the 16-detector instrument. (auth)

12169 INTERFERENCE OF SCALP AND SKULL WITH EXTERNAL MEASUREMENTS OF BRAIN ISOTOPE CONTENT. PART 1. ISOTOPE CONTENT OF SCALP AND SKULL. Oldendorf, William H.; Iisaka, Youichi (Wadsworth Hospital, Los Angeles. Univ. of California, Los Angeles). J. Nucl. Med.; 10: 177-83(Apr 1969).

Tissue volumes and weights of brain, scalp and skull were estimated from postmortem radiography in ten subjects. The isotope distribution in animal tissues for ^{99m}Tc-pertechnetate and ^{131}I-IHSA was defined as a function of time. The brain isotope concentration was low relative to other tissues. Blood volumes were calculated using ^{125}I-IHSA in the animal tissues. The percentage of total cranial counts originating in brain was calculated for a total cranial head counting geometry. Restriction of collimation in total-head counting to exclude the vertex scalp and skull would improve the brain-to-nonbrain tissue count ratio. Isotope data described here suggest an explanation for the halo seen on ^{99m}Tc head scans. A difference was shown between calvarial scalp and lumbar skin isotope content for both ^{99m}Tc-pertechnetate and ^{131}I-IHSA. Brain mechanisms for keeping most foreign or externally introduced solutes low in concentration are briefly discussed. The effect of scalp and skull on external counting of a nondiffusible bolus passage is discussed in relation to the first derivative method of measuring brain blood pool transit time. A tracer technique is suggested which would allow correction for the superficially originating count in scalp and skull. (auth)

12170 THE SIGNIFICANCE OF THE TRANSPORT TIME FOR ^{131}I-HIPPURAN IN RADIOISOTOPE NEPHROGRAMS. Trapp, P.; Petersen, F.; Adam, A. (AK St. Georg, Hamburg). Fortschr. Geb. Roentgenstr. Nuklearmed.; 111: 649-64(Nov 1969). (In German).

A scheme of differential diagnosis depending on t_{max}-deviation in isotope nephrograms using a scintillation camera was attempted. Using a radioisotope nephrogram and a scintillation camera, three main pathological groups were identified (reduced urine flow rate; increase in intrarenal urine volume; and abnormalities of renal cellular ^{131}I-hippuran transport). The significance of other radioisotope parameters and the value of radiological examination for the elucidation of t_{max} changes are briefly discussed. (auth)

12171 CHOICE OF ISOTOPES FOR RENAL SCANNING. Bondarchuk, A. K. (Odessa Inst. of Medicine). Med. Radiol.; 14: No. 11, 53-7(Nov 1969). (In Russian).

Merits and disadvantages of ^{203}Hg- and ^{197}Hg-tagged neohydrin employed in renal scanning and the dependence of its amassment upon the function of the renal parenchyma are discussed. Renal scanning with the use of ^{131}I-hippuran is recommended in reduced tubular secretion and delayed evacuation, as seen on the isotope renogram. (auth)

12172 COMPUTER-FOCUSING USING AN APPROPRIATE GAUSSIAN FUNCTION. Nagai, Teruo; Fukuda, Nobuo; Linuma, T. A. (National Inst. of Radiological Sciences, Chiba, Japan). J. Nucl. Med.; 10: 209-12(May 1969).

Because the conventional radioisotope image can be regarded as the convolution of true radioisotope distribution in tissue and the system-response function of the imaging system used, the blur in an observed image that is introduced by poor resolution can be made much smaller by solving the convolution integral equation. An iterative approximation method has been developed previously, but requires considerable computer time. A new method is reported for image restoration in area scans that is called the differential-operator method. The mathematical foundation of the method is the convolution integral equation with Gaussian kernel function is solved using the Fourier integral representation of the Gaussian function. The advantages of the differential-operator method are easier programming, less expense (less computer time), and potential applicability to on-line real-time data processing. (C.O.)

12173 SIMPLIFIED PREMEDICATION FOR BRAIN SCANS AND OTHER RADIOISOTOPE TESTS. Samuels, L. D.; Hipple, T. F. (Children's Hospital, Columbus, Ohio). J. Nucl. Med.; 10: 254(May 1969).

Sodium or potassium perchlorate given by mouth before administration of ^{99m}Tc competes for binding sites in choroid plexus and thyroid and allows better scans with lower radiation exposure to the thyroid and stomach. A premedication solution that is pleasant tasting and acceptable to children as well as adults has been devised. The formulation used is given. (C.O.)

12174 X RAY DIAGNOSIS IN ONCOLOGY. Lupo, M. Minerva Med.; 60: 3176-87(1 Sep 1969). (In Italian).

A brief review is given of the use of scintillation scanning with ^{47}Ca, ^{131}I, or ^{85}Sr for the diagnosis of neoplasms. The effectiveness of radioisotope scanning and radiography are compared for the diagnosis of neoplasms of the larynx, thyroid, mammary glands, lungs, intestine, liver, pancreas, gonads, and central nervous system. (C.H.)

12175 DETECTION OF THE HETEROZYGOTE OF WILSON'S DISEASE. O'Reilly, S.; Weber, P.; Pollycove, M.; Shipley, L. (Univ. of California School of Medicine, San Francisco). J. Nucl. Med.; 10: 143-4(Mar 1969).

Studies were carried out in six normal control subjects, three

known homozygotes, and two presumptive heterozygotes of Wilson's disease, and in two siblings of one of the known homozygotes. One of these siblings was judged to be normal and the other heterozygous on the basis of their whole-body copper turnover and other studies. Two separate studies were made on one of the homozygotes. Each subject in the fasting and resting state was given from 15 to 127 μCi of virtually carrier-free ^{67}Cu (physical half-life approximately 61 hr) which had been previously incubated with 10 ml of the subject's plasma to ensure protein-binding of the tracer. In each case background radioactivity in the whole body had been determined before injection. If no excretion took place, the absorbed whole-body dose would be less than 0.49 mRads/μCi injected, or between seven and 62 mRads in the dose range used. There is therefore no radiation hazard in such studies. Each subject was counted daily or every other day in the whole-body counter for up to three weeks. Excreta were collected and counted from most of the subjects, and the results confirmed the validity of using the whole-body-counter data to determine total-body turnover and retention. The half-time for copper turnover in the whole-body was determined. The mean half-time for seven normal subjects was 26 days with a range of 22 to 33 days. The three homozygotes had half-times of 129, 104 to 108, and 185 days while the presumptive heterozygotes had half-times of 73, 44, and 60 days. A clear-cut separation between normal, homozygote and heterozygote is suggested by these half-times. (C.H.)

12176 RADIATION INSTRUMENT CALIBRATION SYSTEM. Trout, E. Dale; Kelley, John P.; Weaver, Kenneth E. (Oregon State Univ., Corvallis). Radiology; 93: 1027-32(Nov 1969).

A radiation instrument calibration facility can be set up using commercially available components. The accuracy of calibration is well within the range necessary for most work. The accuracy of the calibration exposure rate is a function of the stability of the x-ray beam, the quality of the readout system, and the care exercised in doing the work. The accuracy to which an instrument can be calibrated will involve the design and stability of the instrument being calibrated. The accuracy of the instrumentation in general use has been determined by the inherent accuracy of the instruments, not by the limitations of the methods of calibration used by the manufacturers or the National Bureau of Standards. The satisfaction and convenience of being able to do the work in one's own laboratory, the ability to calibrate experimental instruments, and the use of the equipment for instructional exercises make such a project well worth the effort. (auth)

12177 VISUALIZATION OF RENAL STRUCTURE AND FUNCTION WITH CHELATED RADIONUCLIDES. Hosain, Fazle; Reba, Richard C.; Wagner, Henry N. Jr. (Johns Hopkins Medical Institutions, Baltimore). Radiology; 93: 1135-8(Nov 1969).

Indium-113m and ^{169}Yb chelated with diethylenetriaminepentaacetic acid (DTPA) were useful for evaluation of kidney structure and function by imaging with rectilinear scanner and gamma camera. Both the agents are cleared by glomerular filtration and clearly outline the kidneys soon after intravenous injection. In some cases of severe renal insufficiency when ^{197}Hg-chlormerodrin failed to visualize the kidneys, the chelates were helpful in defining renal size, shape, and position. Serial imaging with gamma camera after intravenous injection of 10 to 15 mCi of any of these chelated radionuclides permitted visualization of early uptake, renal structure, and subsequent excretion into the renal pelvis. Whole-body radiation doses were evaluated with special reference to kidney scanning with the chelates of ^{68}Ga, ^{113m}In, ^{51}Cr, and ^{169}Yb. (auth)

12178 DESK-TOP DIGITAL COMPUTER IN NUCLEAR MEDICINE. Cohen, M. B. (Univ. of California, Los Angeles, Veterans Administration Hospital, Sepulveda, Calif.); Zimmerman, K.; Patton, D. D. Radiology; 93: 1117-21(Nov 1969).

The applications of a desk-top digital computer to operations in a nuclear medicine department are described. Its use is outlined for isotope inventory control, radioisotope procedures and calculations, determination of radiation dose, and general administrative, statistical, and research applications. The computer is described, and features of its operation are outlined. It was found to be an invaluable aid. (auth)

12179 EVALUATION OF ^{169}Yb DIETHYLENETRIAMINE-PENTAACETIC ACID AS A BRAIN-SCANNING AGENT. Gilday, David L.; Reba, Richard C.; Hosain, Fazle; Longo, Rosemary; Wagner, Henry N. Jr. (Johns Hopkins Medical Institutions, Baltimore). Radiology; 93: 1129-34(Nov 1969).

Ytterbium-169-diethylenetriaminepentaacetic acid (DTPA) was developed as a brain-scanning agent and compared to ^{99m}Tc-pertechnetate. In experimental ependymomas in mice the tumor to brain concentration ratios were about 18 to 1 and in human brain tumors, the ratios averaged 4 to 1. These values were comparable to those obtained simultaneously with ^{99m}Tc-pertechnetate. The minimal lethal dose of the calcium-sodium complex of DTPA in rabbits and dogs was at least 7,400 to 10,000 times the dose used in brain scanning. The scan and camera images were comparable in fifty paired patient studies performed with ^{99m}Tc-pertechnetate and ^{169}Yb-DTPA. Because of the long physical half-life and the stability of ^{169}Yb-DTPA it is a convenient and inexpensive brain-scanning agent that gives high quality images. (auth)

12180 CIRRHOSIS AND THE HEPATIC PHOTOSCAN. Cohen, Marvin B. (Veterans Administration Hospital, Sepulveda, Calif.). Radiology; 93: 1139-44(Nov 1969).

A study of 13 patients with cirrhosis and large localized defects on hepatic photoscans is reported. The absence of hepatoma or metastatic tumor was authenticated at surgery or autopsy. Photoscans were performed with both ^{198}Au colloid and ^{99m}Tc-S colloid in each case. Better resolution of the defect was obtained with the ^{99m}Tc-S colloid, but the degree of splenic concentration of this nuclide was found to be quite variable. Increased splenic concentration of colloidal gold was a reliable indicator of the cirrhotic etiology of the localized defect on the photoscan, but normal splenic concentration was noted in four patients. In five patients, localized scan defects were unchanged following portacaval anastomosis. (auth)

12181 ^{131}I HIPPURAN IN THE EVALUATION OF TRANSPLANTED KIDNEYS. Egleston, Thomas A.; Acchiardo, Sergio; Rodriguez-Antunez, Antonio; Nakamoto, Saturo (Cleveland Clinic Foundation). Radiology; 93: 1145-8(Nov 1969).

Estimation of the rate of clearance of ^{131}I-Hippuran from the blood by means of an external probe is a reliable index of the status of the transplanted kidney. Experience with 50 studies has shown that this is of value not only in detecting abnormal renal status, but also in measuring the degree of abnormality involved. It is useful in following the patient's response to treatment aimed at reversing the rejection process. The test is simple to perform and demands no greatly sophisticated equipment. (auth)

12182 DISPLAY AND STORAGE SYSTEM FOR RADIONUCLIDE IMAGES. Langan, James K.; Wagner, Henry N. Jr. (Johns Hopkins Medical Institutions, Baltimore). Radiology; 93: 1197-8(Nov 1969).

A system for the storage and display of radioisotope scan data is described. Gamma camera images are recorded directly on 35 mm film, and rectilinear scans, radiographs, and written reports are photographed on 35 mm film. The photographic images are mounted on standard aperture cards, and the cards are keypunched with the patient's identification number as well as the type and result of the study. The photograph may be projected life-size onto a translucent screen for viewing, and measurements can be made directly on the screen without correction factors. Cards may be copied for the use of the physician, and the aperture card always remains in the permanent file. The cards may be studied by means of microfilm viewers. The cards may be filed and retrieved by hand or machine sorting may be used. (C.H.)

12183 ALARM OVER ORAL BARIUM ADMINISTRATION BEFORE BONE SCANNING. Harbert, John C. (National Inst. of Health, Bethesda, Md.). J. Nucl. Med.; 10: 145-6(Mar 1969).

A review of fifty ^{85}Sr bone scans showed that fully 25% of scans required repeating at least one view. By far the greatest number of these repeat scans (10 out of 13) were undertaken to rule out activity within the large bowel. In view of the long scanning time and appreciable patient discomfort involved in ^{85}Sr bone scanning, every effort should be made to cleanse the large bowel prior to scanning the spine and pelvis. Laxatives or enemas should be used where appropriate. If activity is seen within the pelvis or spine in an area that could be within bowel, a rescan should be made to rule out bowel activity following a repeat laxative order. In two of the 50 cases reviewed, activity thought to be in bowel subsequently proved to be bony lesions. In another case activity thought to represent a lumbar spine lesion proved to be bowel activity. The assumption that abnormal scan activity is within large bowel because it superimposes the bowel seen roentgenographically seems unwarranted. Rather than exclude false positives, it will result in false negatives. The way to exclude false positives is to rescan, and this should include both spine and pelvis because bowel activity may occasionally superimpose the lumbar and lower thoracic spine. It is postulated that the administration of oral barium prior to bone scanning to better outline the large bowel roentgenographically is a dangerous inference, as demonstrated by a case that is described. (C.H.)

12184 EFFECT OF SKULL PLATES ON POSTOPERATIVE BRAIN SCANS. Cradduck, T. D.; Duggan, H. E. (Foothills

Hospital, Calgary, Alberta). J. Nucl. Med.; 10: 140-2(Mar 1969).

A case history is presented in which the effect of a tantalum skull plate on a ^{99m}Tc brain scan is shown. This led to the determination of percentage transmission figures for various skull plate-radionuclide combinations. The effect of tantalum skull plates on the 140 keV radiation from ^{99m}Tc is severe. (auth)

12185 ^{85}Sr SCINTIMETRY IN OSTEOARTHRITIS OF THE KNEE. Bauer, Goeran C. H. (Cornell Univ. Medical Center, New York); Smith, Edward M. J. Nucl. Med.; 10: 109-16(Mar 1969).

Earlier measurements of ^{47}Ca and ^{85}Sr uptake in the spine and the hip in man have demonstrated that osteoarthritis is associated with an increased rate of bone-tissue turnover. Results are reported from a study aimed at correlation in osteoarthritis of the uptake of ^{85}Sr to radiologically visible anatomic details. Fourteen knee joints in nine patients were studied; the knees were afflicted with primary osteoarthritis of the medial or lateral type. Two weeks after parenteral injection of 100 μCi ^{85}Sr the tracer distribution in the knee region was determined by scintimetry. A focusing collimator gave measurements of ½ to ¼-in.^{2} areas superimposed on the radiograms. It was found that the uptake of ^{85}Sr was higher than normal in those areas of the osteoarthritic knee where osteosclerosis was a predominant radiographic feature. Additional observations showed that osteonecrosis, even in the absence of radiographic abnormality, is associated with higher ^{85}Sr values than is osteoarthritis. Radionuclide scintimetry may provide an additional parameter for evaluating arthropathy. The lack of other numerical indices in conditions such as osteoarthritis and osteonecrosis supports this contention. (auth)

12186 ^{123}I THYROID MEASUREMENTS WITH A Ge(Li) DETECTOR. Sodd, V. J.; Wellman, H. N.; Branson, B. M. (National Center for Radiological Health, Cincinnati). J. Nucl. Med.; 10: 136-9(Mar 1969).

The high resolution of the Ge(Li) semiconductor detector and its reasonably good counting efficiency for low-energy gamma rays suggest its use in nuclear medicine. A Ge(Li) detector with a sensitive volume of 4.2 cm^3 was used to measure human thyroid uptake of ^{123}I. A Lucite neck phantom was used to calibrate this detector system for varying thyroid depths using the P/S ratio technique. The percent uptake measured in two subjects using the calibrated Ge(Li) detector agreed with measurements made with a dual NaI(Tl) detector. The future of the semiconductor detector for low-energy in vivo measurements becomes more promising as larger detectors become available. (auth)

12187 PROGNOSTIC VALUE OF RADIOISOTOPE RENOGRAMS IN KIDNEY TRANSPLANTATION. Staab, Edward V.; Kelly, William D.; Loken, Merle K. (Univ. of Minnesota Hospitals, Minneapolis). J. Nucl. Med.; 10: 133-5(Mar 1969).

Serial ^{131}I-orthoiodohippurate renograms after renal transplantation in 36 patients were analyzed using two parameters; time in minutes to peak; and height at 20 min over height at peak. Excellent correlation between abnormal serial renogram patterns and the clinical diagnosis of rejection reaction was established. In some cases the renogram changes distinctly preceded the clinical diagnosis. (auth)

12188 HYPOPROTEINAEMIAS ASSOCIATED WITH HELMINTHIC INFECTIONS, WITH SPECIAL REFERENCE TO GASTROINTESTINAL PARASITES. Nielsen, K. (Royal Veterinary and Agricultural Coll., Copenhagen). pp 125-32 of Isotopes and Radiation in Parasitology. Vienna; International Atomic Energy Agency (1968).

From Meeting on the Use of Isotopes and Radiation in Study and Control of Parasitic Diseases, Vienna, Austria. See STI/PUB-181; CONF-670738.

The syndrome of protein-losing gastroenteropathy in man is briefly outlined, with special reference to the detection of an abnormal enteric loss of serum proteins by means of labeled macromolecules, e.g., ^{131}I polyvinylpyrrolidone, ^{51}Cr albumin, ^{67}Cu ceruloplasmin, ^{59}Fe iron-dextran and ^{131}I- or ^{125}I-labeled serum proteins. These methods have not been extensively used in veterinary research with large animals. Several diseases of domestic animals are rather close analogues to human disorders in which a gastrointestinal protein loss has been demonstrated. Hyperplastic gastritis in cattle and swine (caused by Ostertagia ostertagi and Hyostrongylus rubidus) are examples of such analogues. Others are regional enteritis and ulcerative colitis in pigs. Studies of these diseases have revealed that a gastrointestinal protein loss is an essential factor in the development of pronounced hypoproteinemia. The probable site of this enteric protein loss is the dilated villous lymphatics (chylus ampoules) that are seen throughout the small intestine during chronic diarrhoeal conditions of cattle and swine. However, the available evidence indicates that the loss of serum proteins via the digestive tract in animals is not solely related to the presence of lymphangiectasias or to other morphological lesions. Diarrhoea per se seems to be an important factor in triggering the enteric protein loss. This theory is sustained by the finding that hypercatabolism (due to the gastrointestinal loss) is restricted to diarrhoeal phases of the disease, whereas hypocatabolism follows when the animal enters a quiescent phase or recovers. Accordingly, studies of the basic aspects of diarrhoea appear to be very important. (auth)

12189 ANAEMIAS ASSOCIATED WITH HELMINTHIC INFECTIONS. Jennings, F. W. (Univ. of Glasgow). pp 133-40 of Isotopes and Radiation in Parasitology. Vienna; International Atomic Energy Agency (1968).

From Meeting on the Use of Isotopes and Radiation in Study and Control of Parasitic Diseases, Vienna, Austria. See STI/PUB-181; CONF-670738.

Isotopic methods which have been utilized in the study of anemias, particularly those associated with helminthic diseases, are reviewed. The main interest is in the detection and quantitation of gastrointestinal hemorrhage, and various isotopic methods currently employed in these measurements are discussed. The value of the various methods is acknowledged, but emphasis is made of the many inaccuracies which can be encountered, in particular the variations found between the various species. Although these factors do not invalidate the general results, it underlines the necessity of careful evaluation of the findings. A brief review of the isotopic methods utilized in studying erythropoietic pathways is also given and it is hoped that it will serve as a basis for further discussions. (auth)

12190 SIMPLE METHOD FOR OBTAINING DYNAMIC QUANTITATIVE INFORMATION FROM THE GAMMA CAMERA. Holroyd, A. M. (Royal Postgraduate Medical School, London); Jones, T. Phys. Med. Biol.; 14: 631-8(Oct 1969).

A method is described by which a gamma camera provides localized dynamic quantitative information in clinical radioisotope investigations. Storage of primary data by analogue magnetic tape recording allows repeated subsequent reproduction of the original display, and its stability is continuously checked and maintained. Scintillations in areas of interest are counted using a photomultiplier with single channel γ-ray spectrometry equipment. Three current applications are described. (auth) (UK)

12191 SCANNING MEDIASTINAL LYMPH NODES. Langhammer, H.; Hoer, G.; Pabst, H. W.; Hertel, E. (Univ., Munich). J. Nucl. Med.; 10: 479-51(Dec 1969).

Experiments showed that visualization of mediastinal lymphatics, including hilar lymph nodes, may be obtained by accurate injection of colloidal ^{198}Au into the pleural space (indirect isotope lymphadenography). The method is superior to previously developed procedures based upon intrapulmonary injection. (auth)

12192 DETERMINATION OF RENAL PLASMA FLOW BY A SINGLE INJECTION OF ^{131}I-ORTHOIODOHIPPURATE AND TWO BLOOD SAMPLES: EVALUATION OF THE PRECISION OF THIS METHOD. Vitye, Barna; LeBel, Etienne (Notre-Dame de la Merci Hospital, Montreal). J. Nucl. Med.; 10: 735-6(Dec 1969).

Renal plasma flow was determined in 20 patients by a single injection of ^{131}I-orthoiodohippurate using two blood samples at 8 and 17 min to determine the slope. A second determination done in each patient revealed a high degree of reproducibility. (auth)

12193 CATHETER SEMICONDUCTOR RADIATION DETECTOR FOR CONTINUOUS MEASUREMENT OF CARDIAC OUTPUT. Ueda, Hideo (Tokyo Univ.); Sasaki, Yashito; Iio, Masahiro; Kaihara, Shigekoto; Machida, Kikuo; Ito, Iwao; Takayanagi, Seiichi; Kabyashi, Tetsuji; Sugita, Tohru. J. Nucl. Med.; 10: 713-21(Dec 1969).

A catheter semiconductor radiations detector (CASRAD) was developed for in vivo measurements of beta radiation in blood and tissue. The detector element is a silicon p-n junction diode which is 2.3 mm in dia and 1 mm thick. The specially developed subminiature noiseless coaxial cable, approximately 120 cm long, is connected to the detector head. The entire probe is covered with a polyethylene tube to make it watertight. The maximum outer diameter of the probe is about 3.2 mm, and a completely transistorized low-noise charge sensitive preamplifier was developed to eliminate microphonic noise. The following are some of the important characteristics of the detector: A low operating voltage of 10 to 40 volts with constant sensitivity in this range; lineality between counting rate and radioisotope concentration; sufficient noise discrimination and good spatial resolution. It was proved that this detector can be safely inserted into the body and is suitable for measuring localized beta activity in vivo. The CASRAD probe was used to continuously measure the right cardiac output

based on flow-dilution relationship with ^{85}Kr saline solution used as an indicator. In the studies performed on anesthetized dogs, the probe was placed in the outflow tract of the right ventricle where it detected the ^{85}Kr radioactivity infused at a constant rate into the femoral vein. Changes in the cardiac output caused by epinephrine injections were recorded continuously by this method. Comparison of the CASRAD method with IHSA dilution and electromagnetic flowmeter methods in the determination of cardiac output revealed good agreement between the results. (auth)

12194 LUNG SCANNING USING ^{99m}Tc-LABELED MACROAGGREGATED FERROUS HYDROXIDE (Tc-MAFH) AS THE PERFUSION AGENT. Boyd, R. E. (Australian Atomic Energy Commission, Sutherland, New South Wales); Ackerman, S. A.; Morris, J. G.; Huberty, J. P. J. Nucl. Med.; 10: 737-9(Dec 1969)

A method for preparing ^{99m}Tc-macroaggregated ferrous hydroxide (Tc-MAFH) is described. Tc-MAFH is easy to prepare and possesses adequate radiochemical stability. The majority of the labeled macroaggregates lie in the optimal size range of 20 to 50 microns. This radiopharmaceutical enables the superior physical properties of ^{99m}Tc to be more effectively used in lung perfusion studies. (auth)

12195 UTILIZATION OF CHARACTERISTIC X-RADIATION TO IDENTIFY GAMMA RADIATION ORIGINATING EXTERNAL TO SKULL. Oldendorf, William H. (Veterans Administration Center, Los Angeles. Univ. of California, Los Angeles). J. Nucl. Med.; 10: 740-2(Dec 1969).

Skull transmission data for the gamma and characteristic x ray emissions of several common nuclides are presented. There is production of 18-keV x rays by ^{99m}Tc and 24-keV x rays by ^{113m}In which are effectively absorbed by skull whereas the high-energy gamma is insignificantly absorbed. A method is suggested in which the γ radiation originating external to skull can be differentiated from x rays originating inside skull. Gamma ray production will bear a fixed numerical relationship to the characteristic x rays produced. With daughter products of decay with atomic numbers between 40 and 50 the low-energy x rays counted externally all originate external to skull because skull is opaque to those generated inside. This would allow the subtraction of externally originating γ radiation produced concomitantly with the externally detected characteristic x radiation. The method is most suited to nuclides with atomic numbers between 40 and 50 since the characteristic x radiation produced in this range is nearly completely absorbed by skull but will penetrate the scalp. Both ^{99m}Tc and ^{113m}In seem well suited to this method. (auth)

12196 DEMONSTRATION OF THE EFFECT OF IRRADIATION ON CANINE BOWEL USING IN VIVO PHOTOGRAPHIC MAGNIFICATION ANGIOGRAPHY. Bosniak, Morton A.; Hardy, Mark A.; Quint, Jerome; Ghossein, N. A. (Yeshiva Univ., Bronx, N. Y.). Radiology; 93: 1361-8(Dec 1969).

Utilizing a technic of in vivo photographic magnification angiography, we have studied the effects of high doses of radiation (1,500 to 3,000 R single dose) on canine bowel. The findings have been correlated with in vitro injection studies as well as with gross and microscopical pathological changes of the irradiated bowel. A prominent feature of these studies was marked vascular spasm localized to the irradiated bowel segment in the first few weeks following irradiation. This spasm could be reversed by the intra-arterial injection of papaverine. Thrombosis and arterial luminal narrowing of the vessels of the bowel wall were major findings in the five-to-nine week period, with early revascularization and repair at twelve weeks. Angiographic demonstration of these findings and a description of the radiographic technic are included in the report. (auth)

12197 REGIONAL PULMONARY FUNCTION EVALUATION USING ^{133}Xe, A SCINTILLATION CAMERA, AND COMPUTER. Loken, Merle K.; Medina, Jose R.; Lillehei, James P.; L'Heureux, Philippe; Kush, George S.; Ebert, Richard V. (Univ. of Minnesota Hospitals, Minneapolis). Radiology; 93: 1261-6(Dec 1969).

The use of ^{133}Xe together with a scintillation camera and its associated interface equipment for computer processing of data provides a worthwhile approach to the evaluation of pulmonary function. By this technic it is possible to study pulmonary function on a regional basis involving areas of the lung as small as 1 cm^2 in cross section. Serial photoscintigrams, together with computerized results of ventilation and perfusion indices and ventilation-perfusion ratios, are obtained on all patients in whom pulmonary function is being evaluated. (auth)

12198 VALUE OF THE COUPLED INVESTIGATION IN THE STUDY OF THE PANCREAS: PANCREATIC ARTERIOGRAPHY AND SCANNING. Dubarry, J. J.; Blanquet, P.; Tavernier, J.; Beraud, Cl.; Beck, Cl.; Le Bras, M.; Pigneux, A.; Quinton, A. J. Radiol., Electrol., Med. Nucl.; 50: 703-6(Oct 1969). (In French).

The complementary use of scanning and arteriography for studies of the pancreas is described. Following scanning with ^{75}Se-labeled methionine a multichannel analyzer was used for storing information detected. The technique proved to be reliable and valuable in 180 cases. In some instances the method was not adequate and had to be supplemented by arteriography. In five of ten cases complementary results of arteriograms and scanning made possible an accurate diagnosis of pancreatic pathology. (auth)

Radiotherapy

Refer also to abstracts 11739, 11950, 12074–12076, 12079, 12084, 12220, 12266, 12303, and 12310–12317.

12199 (STI/PUB-177) DIRECTORY OF HIGH-ENERGY RADIOTHERAPY CENTRES. (International Atomic Energy Agency, Vienna (Austria)). May 1968. 189p. IAEA $3.50.

This Directory lists radioisotope and other high-energy teletherapy installations (i.e., betatrons, linear accelerators, van de Graaff machines, etc.) throughout the world. Information obtained mainly by questionnaires was transferred to computer cards for automatic sorting, retrieval and statistical analysis, and for the final print-out of the Directory. The following items are listed, where applicable, for each institution; Address; Radiotherapist(s); Physicist(s); Manufacturer of treatment unit; Model; Date of installation; Isotope; Diameter of source; Date of source renewal; Dose rate or curies; Date of dose rate or curies. For non-isotope units, items from isotope on are replaced by data for x-ray and electron energy. A total of 1578 radiotherapy centers in 62 countries are covered by this publication and details are given on 2074 teletherapy treatment units. Summarizing tables for easy reference present information on the distribution and increasing use of high-energy teletherapy equipment. This Directory supersedes an earlier (1962) list of medical institutes equipped with high-energy teletherapy units. (auth)

12200 RADIOTHERAPY OF INOPERABLE BREAST CANCER. Schmidt-Hermes, Heinz Josef (Univ., Homburg, Ger.). Strahlentherapie; 138: 394-7(Oct 1969). (In German).

Description of an irradiation technique for inoperable breast carcinomas is presented. The technical modalities are outlined. The advantage of this simple and easily reproducible technique is stressed, and also the homogenous dose distribution obtained in spite of individual variation of the breast and thorax forms. (auth)

12201 EXPERIMENTAL STUDIES ON COMBINATION TREATMENT WITH RADIATION AND CYTOSTATIC AGENTS. PART VII. CARCINOLYTIC STUDIES WITH 5-FLUORURACIL, NATULAN, AND PRORESID ON CROCKER SARCOMAS IN MICE. Ringleb, Dietrich; Krieg, Robert; Sauer, Dieter (Univ., Giessen, Ger.). Strahlentherapie; 138: 423-8(Oct 1969). (In German).

Every 48 hours mice were given intraperitoneal injection of 5 × 3.3 or 8 therapeutic units (= 1% of LD_{10}) of the alkylating agent Natulan, the antimitotic Proresid and the antimetabolite 5-FU for the treatment of a Crocker-sarcoma. Combined with tangential irradiation of 5 × 300 R, the cure rate at 3 months is the same as with radiation alone. In most of the experiments, antagonistic effects were observed during radiotherapy combined with Exdoxan. The early effect, the lethality in 4 or 6 weeks, however, was enhanced in the combined treatment, when compared to the chemotherapy or radiation alone. The evolution of the syncytostatic effect on normal and tumor tissues seems not to be due to a therapeutic synergism. (auth)

12202 RADIOLOGICAL ASPECT OF LATE POST-IRRADIATION CHANGES OF THE SIGMOID. Baroncelli, G.; Bellizzi, C. Ann. Radiol. Diagn.; 41: 490-515(1968). (In Italian).

Complications of the colon are described that were observed in 51 patients following radiotherapy of pelvic neoplasms. The fractionated radiation doses used for therapy resulted in exposure of the colon to radiation doses ranging from 2000 to 4000 rad. Methods for the diagnosis of late radiation injuries of the sigmoid section of the colon are discussed. (C.H.)

12203 SOME ASPECTS OF ELABORATING EQUIPMENT FOR INTRACAVITARY IRRADIATION OF MALIGNANT NEOPLASMS. Rimman, A. F.; Stankevich, A. A.; Sul'kin, A. G.; Komar, V. Ya.; Protopopov, P. B. Med. Radiol.; 14: No. 11, 31-8(Nov 1969). (In Russian).

A brief historical review of the trends marking the progress of work aimed at creating and improving hose units for intracavitary irradiation of malignant tumors is presented. The use of hose units in the treatment with consecutive introduction tends to reduce drastically the radiation load on the medical staff and simplifies the technology of intracavitary therapy. (auth)

12204 EVALUATION OF A COMBINED AND OPERATIVE TREATMENT OF BRAIN TUMORS WITH MANIFESTATIONS OF OCCLUSIVE HYDROCEPHALIA IN CHILDREN. Rostotskaya, V. I.; Lokshina, A. M. (Inst. of Neuro-Surgery, Moscow). Med. Radiol.; 14: No. 11, 38-43(Nov 1969). (In Russian).

A comparative appraisal of methods used in the treatment of children with inoperable tumors of the III ventricle, mesencephalon, and with craniopharyngogliomas attended by occlusive hydrocephalia is presented. The results of treatment in 37 cases of the said affections subjected to a combined treatment (surgery and beam therapy) and in 37 others that involved surgery alone are analyzed. Statistical processing of the data on the life-span and on time periods marking the onset of the continued tumor growth failed to reveal any substantial difference in figures relating to the 2 groups of patients under consideration. However, in a number of patients with clinical symptoms of the continued growth the radiation therapy proved effective. For this reason indications for the institution of postoperative radiation therapy should be strictly individualized. (auth)

12205 SYSTEM FOR SUSTAINED INTRAVENOUS INFUSION OF A STERILE SOLUTION OF ^{137m}Ba-ETHYLENEDIAMINE-TETRAACETIC ACID (EDTA). Castronovo, Frank P. Jr.; Reba, Richard C.; Wagner, Henry N. Jr. (Johns Hopkins Medical Institutions, Baltimore). J. Nucl. Med.; 10: 242-5(May 1969).

A prototype infusion system was successfully developed for the continuous administration of ^{137m}Ba directly eluted from its ^{137}Cs parent. This same principle can be applied to a variety of long-lived-parent, short-lived-daughter radioisotope relations. (auth)

12206 CLINICAL HYBAROXIC RADIOTHERAPY AFTER FIVE YEARS. Wildermuth, Orliss; Warner, Glenn A.; Marty, Raymond (Swedish Hospital-Medical Center, Seattle). Radiology; 93: 1149-54(Nov 1969).

While the results of hybaroxic radiotherapy do not measure up to the predictions, they compare favorably with conventional radiation therapy. Continuing studies indicate that results may improve with refinements of the technic. Advantages of tolerance and ease of administration of radiotherapy are now apparent. The radioprotective effect of hypoxia, that attempts were made to repair with hyperbaric oxygen, may have been eliminated by conventional fractionation technics. A method of measurement of oxygen partial pressures within the range of the diffusion of oxygen through living cell matter, namely 150 μ, is desperately needed. After five years, the rate of cure with hybaroxic radiotherapy has still not been doubled as predicted by the oxygen effect principle. (auth)

12207 WHOLE-LUNG IRRADIATION FOR METASTATIC TUMOR. Margolis, Lawrence W.; Phillips, Theodore L. (Univ. of California, San Francisco). Radiology; 93: 1173-9(Nov 1969).

A series of 25 patients treated between 1958 and 1968 for metastatic pulmonary disease was reviewed. A total of 35 areas was treated in these 25 patients. In 10 areas, radiation pneumonitis developed four weeks to three months after treatment. The pneumonitis was symptomatic and was seen roentgenographically in all patients. One patient died of causes directly attributable to irradiation and actinomycin D, and a second died with symptoms of radiation pneumonitis and metastatic disease. Of the seven patients with Ewing's tumor, the disease was controlled locally in two, and one survived five yr after treatment. Among 10 patients with Wilms's tumor, local control was achieved in four but one died of metastatic disease at other sites, and one died of radiation pneumonitis. Two patients survived 4 and 5 yr after treatment without evidence of disease. The only long-term response in the group treated for miscellaneous primary sites was in a patient with Hodgkin's disease. The treatment data were plotted as a function of dose versus the number of fractions and converted into nominal single doses. The safe limit for whole-lung x irradiation with administration of actinomycin D appears to be 700 rets and, without actinomycin D, 1,100 rets. These doses may also be expressed as 2,500 Rads in 20 fractions without actinomycin D, or 1,500 Rads in 15 fractions with actinomycin D. Significant control rates in Wilms's tumor and Ewing's sarcoma can be obtained if doses close to tolerance are used. Booster fields with an additional dose to lesions not regressing completely after whole-lung irradiation are suggested. (auth)

12208 SINGLE-DOSE RADIATION THERAPY IN THE PALLIATION OF METASTATIC DISEASE. Vargha, Zia O.; Glicksman, Arvin S.; Boland, John (Mount Sinai Hospital, New York). Radiology; 93: 1181-4(Nov 1969).

Single-session therapy has clear-cut social and psychological advantages. The quality of survival of the incurable cancer patient can be improved by one trip to the radiotherapy center. It does not erode the remaining life of the patient with prolonged hospitalization; nor does it demand the continuous attention of the radiotherapist, who is already in short supply. In view of the high success rate, low morbidity, and rapidity of treatment as well as the social, psychological, and economic advantages, single session therapy for palliation warrants wider adoption by radiotherapists. (auth)

12209 AN OPERATIVE STAGING SYSTEM AND A MEGAVOLTAGE RADIOTHERAPEUTIC TECHNIC FOR CEREBELLAR MEDULLOBLASTOMAS. Chang, Chu H.; Housepian, Edgar M.; Herbert, Charles Jr. (Columbia Univ., New York. Columbia-Presbyterian Medical Center, New York). Radiology; 93: 1351-9(Dec 1969).

An operative staging system for cerebellar medulloblastoma with the International TNM staging designation based on an analysis of 100 operative cases at the Neurological Institute, Columbia-Presbyterian Medical Center is presented, and a megavoltage technic to encompass the whole neuroaxis for radiotherapy of cerebellar medulloblastoma is described. The megavoltage technic has improved dose distributions in the cranium, minimized the junctional hot spots in the spine, and has reduced the radiation sequelae of skin, lens, and bone. The proposed operative staging system seems to have a definite prognostic value and may guide radiotherapists to a more intensive attack on the strategic area of major tumor involvement in advanced cases in addition to the routine whole neuroaxis irradiation; therefore, further improvement of survival rate may be derived. Of 24 children under the age of fifteen years who underwent surgery for cerebellar medulloblastoma and were irradiated by this megavoltage technic since 1962, 83 per cent are alive at one year, 55 per cent at three years, and 40 per cent after five years. The survivors are in good functional and physical condition with few or no neurological deficits. We believe that the markedly improved results are attributed to the new and carefully executed megavoltage technic and that medulloblastoma is a highly radiosensitive and radiocurable malignant brain tumor. (auth)

12210 TREATMENT OF CANCER OF THE RECTUM (STUDY OF A SERIES OF 127 CASES). Gary-Bobo, J.; Villaret, B.; Garrigues, J. M.; Dousset, C. J. Radiol., Electrol., Med. Nucl.; 50: 722-4(Oct 1969). (In French).

When surgical and radiation techniques were used separately for treatment of cancer of the rectum, a large part of their effectiveness was lost. It appears that amelioration of symptoms is a function of correct planning of a variety of treatments used together. For stage T1 radiotherapy of contact should be used. For stages T2 and T3 surgery should be used to the maximum possibility but should be completed by radiation which prevents a number of pelvic relapses. For stage T4 the maximum radiosurgical association should be used together with new methods of chemotherapy. The latter is the recommended therapeutic scheme. (tr-auth)

Blast and Thermal Effects

12211 (BMI-171-122(Rev.)) AMCHITKA BIOENVIRONMENTAL PROGRAM: BIOENVIRONMENTAL SAFETY STUDIES, AMCHITKA ISLAND, ALASKA. MILROW: D + 7 DAYS REPORT. Kirkwood, James B. (Battelle Memorial Inst., Columbus, Ohio). Oct. 12, 1969; Revised Oct. 17, 1969. 19p. Dep. CFSTI.

Cursory examination of the data collected during the MILROW testtime studies indicates that the immediate effects of the detonation were minimal. Among the changes noted were: Approximately 2,800 cu. yds. of rock and peat materials fell along the Pacific Ocean and Bering Sea coasts, mostly within 2 miles of surface ground zero (SGZ). Several sea stacks were damaged but eagles and other birds were using these for perches within a few hours after the detonation. Sticklebacks were killed by underwater overpressure in two lakes located 0.4 and 0.8 miles from SGZ. Two lakes were partly drained by the subsidence at SGZ. Testtime live box and holding pen experiments did not show any damage to: salmonids in freshwater lakes as near as 0.4 mile from SGZ, sea otters in a pen 4,500 ft from SGZ, marine fish in live boxes less than 2 miles from SGZ, and crabs in a live box at 80 fathoms about 9 miles from SGZ. Visual surveys during beach walks and helicopter flights did not reveal any major damage to freshwater fish (except for the sticklebacks in two ponds), saltwater fish and invertebrates, sea otters and other marine mammals, and birds, that could be attributed to MILROW. Future analysis of photographs taken during the same time period (immediately before and after MILROW) will strengthen or disprove the tentative conclusions made from visual observations. (auth)

Radiation Effects on Animals

Refer also to abstracts 11965, 12044, 12113, and 12124.

12212 (NYO-4034-1) [STUDY OF THE IN VITRO EFFECTS OF IONIZING RADIATION ON GERMINAL EPITHELIUM OF HUMAN TESTIS AND ON STEROID BIOSYNTHESIS OF LEYDIG CELLS, UTILIZING TISSUE CULTURE METHODS]. Progress Report. (Albert Einstein Medical Center, Philadelphia, Pa.). [1969]. Contract AT(30-1)-4034. 27p. Dep. CFSTI.

Methods of preparing histologic sections of testes for radioautography are described. Cultures of fresh tissue were exposed to 225 R of γ radiation and tissues were fixed at intervals from 24 hr to 10 weeks later. Cytological changes in germinal cells are described and photographs of typical cells are presented. From the fourth to the tenth week there was a gradual decline in the total cell count affecting both spermatogonia and the Sertoli cells. A discussion is presented of relative degeneration and proliferation of spermatogonia, spermatocytes, and spermatids. Studies were conducted on effects of in vitro irradiation on steroid biosynthesis in Leydig cells. (H.L.W.)

12213 (ORO-672, pp 23-33) EFFECTS OF RADIATION UPON THE REPRODUCTIVE SYSTEM. Erickson, B. H. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

The effects of γ radiation (150 rads to embryo or fetus, 0.5 to 1 R/min) on the testes of prenatal bulls (determined at 0 to 10 mo postnatal time) in relation to germ-cell mitosis were investigated. Changes in germ-cell radiosensitivity with increasing fetal age were apparently related during the earlier ages to a high rate of mitosis among the germ cells and at the later ages to a combination of germ-cell growth and differentiation and germ-cell mitosis. Data are presented in tabular and graphic form. (C.O.)

12214 (ORO-672, pp 64-5) TISSUE CULTURE. McFee, A. F. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

In vitro–in vivo exposures of swine leukocytes were made using 200, 300, and 400 rad doses of 14.7 MeV neutrons. Comparisons of dose-effect relationships and differences in response were noted. Results indicated that the relation between cellular damage resulting from in vitro irradiation (tissue culture) and in vivo irradiation (intact animal) varied considerably with the evaluation method being employed; damage, however, was more devasting than was expected on the basis of published RBE values. (C.O.)

12215 (ORO-2832-79) RADIATION AND BIOPHYSICAL STUDIES ON VIRUSES AND CELLS. Progress Report, October 12, 1968–October 15, 1969. Shalek, Robert J. (Anderson (M. D.) Hospital and Tumor Inst., Houston, Tex.). 16 Oct 1969. Contract AT(40-1)-2832. 112p. Dep. CFSTI.

Separate abstracts were prepared for three papers. One paper, Principles and Techniques of Stereo Electron Microscopy, by Arthur Cole, was not abstracted. A list of publications is provided. (C.O.)

For abstracts of individual papers see: 11930, 11931, and 12044.

12216 (ORO-3646-8) A COMPARATIVE STUDY OF RADIATION, CHEMICAL, AND AGING EFFECTS ON VIRAL TRANSFORMATION IN VITRO. Annual Progress Report. Coggin, Joseph H. Jr. (Tennessee Univ., Knoxville. Dept. of Microbiology). 26 Dec 1969. Contract AT(40-1)-3646. 21p. Dep. CFSTI.

Mouse fibroblast cells were increasingly sensitive to SV40 or polyoma virus transformation with increasing radiation levels. The data suggest that lesion production in the DNA of the infected cell by x radiation facilitates virus fixation with the host chromosome. It was shown that x-ray pretreatment of hamster embryo cells produced a 30 to 35-fold greater frequency of transformation by adenovirus 31. The possibility that various non-oncogenic viruses may exhibit oncogenic activity in radiation sensitized cells is being evaluated. It was shown that localized uv radiation caused a 12% increase in tumor appearance in SV40 infected animals when irradiation was performed just prior to infection. Studies were conducted on adenovirus 31 tumorigenicity in hamsters exposed to low level, localized x radiation at the site of virus injection. Studies on evaluation of the S antigen as an early index of viral transformation in vitro are being completed. A method for determining the first appearance of transformation antigen is being evaluated for a number of virus-cell combinations using the x-ray pretreatment procedure to yield the desired number of transforming cell clones. Chromosome aberrations induced in hamster cells by x radiation were compared with aberrations induced by viruses. Biochemical and molecular studies included effects of protein inhibitors on transformation, effects of actinomycin D on RNA synthesis, effects of bromodeoxyuridine on transformation of hamster cells by SV40 virus, evaluation of enzymes, and DNA content of SV40 transformed cells. An in vitro method to assay SV40 virus neutralizing antibody in cultured spleen and lymph node cells is described. (H.L.W.)

12217 PROLIFERATION OF MAMMALIAN CELLS IN VITRO AND THE REACTION TO X RADIATION. PART I. METHODS AND ASSESSMENT OF NONLETHAL RADIATION INJURIES. Miltenburger, Herbert Georg (Technische Hochschule, Darmstadt, Ger.). Strahlentherapie; 138: 429-44(Oct 1969). (In German).

Cells of the Chinese Hamster line B 14 F 28 that are nonlethally damaged by x radiation will form in vitro an increased number of microcolonies depending on the absorbed dose. This damage in colony growth is caused mainly by an increase in generation time and an increase in cellular mortality. An analysis of growth curve and of the pedigrees of isolated colonies shows a few generations after irradiation, intracolonial subpopulations with different proliferation characteristics. This is not observed only after irradiation, but also in normal cultures. New methods for the analysis of the radiation reaction of cells and their progeny are described. (auth)

12218 EFFECTS OF RADIATION-INDUCED ELECTROLYTE SHIFTS ON METABOLISM. PART II. EXPERIMENTAL STUDIES ON THE POTASSIUM AND SODIUM DEPENDENCY OF ACETATE METABOLISM IN YEAST. Rink, Hermann; Geissler, Georg; Bergeder, Hans-Dietrich (Univ., Bonn). Strahlentherapie; 138: 489-95(Oct 1969). (In German).

The oxygen consumption of an acetate utilizing yeast was measured by its intracellular electrolyte content. This content depends on the kind and on the concentration of the electrolyte in the culture medium. Irradiation disturbs the ability of the yeast to adjust its Na^+ and K^+ content to the concentration of the medium. This in turn influences the oxygen consumption. Due to the modification of the intracellular electrolyte concentration, the activity of the enzyme coacetokinase is also modified. This disturbs the turnover of the acetate, and in turn influences the citrate cycle and the respiratory chain up to the oxygen consumption. The enzyme coacetokinase must then in this chain be considered as the limiting enzyme that is disturbed by the radiation-induced electrolyte modification. (auth)

12219 BIOFIZIKA I RADIOBIOLOGIYA. VYPUSK 2. MEKHANIZMY BIOLOGICHESKOGO DEISTVIYA IONIZIRUYUSHCHIKH IZLUCHENII. (Biophysics and Radiobiology. Issue 2. Mechanism of Biological Effects of Ionizing Radiation). Gorodetskii, A. A. (ed.). Kiev; Naukova Dumka (1968). 232p.

Forty articles are included on the mechanisms for the biological effects of x rays, neutrons, protons, and radioactive isotopes on organisms. Phenolase activation during x irradiation of the thirosine-phenolase system, the influence of x rays and certain chlorethylamines on the content of adenosintriphosphoric acid in white rats and effects of high-polymer DNA on nucleic acid content during radiation sickness are discussed in the first several articles. Physico-chemical changes in the muscle tissues following radiation and premortal treatment with adrenaline, changes of lines of electron paramagnetic resonance in γ irradiated glycol, and cholesterin proteid metabolism in normal and irradiated animals are reviewed in the next series of articles. The following group of articles covers data on thermal stability of protein in blood serum and sugar content in x-irradiated animals, biological effects of 120 MeV protons, effects of tritium and ^{210}Po injected into dogs. Effects of γ rays on growth of mold fungus and on metabolism in fruits are estimated as well as the isotopic exchange between algae and seawater. Sensitivity and radioresistance of the nervous system, galascorbin influence on skin reactions to radiation, and the role of the adrenal glands in early necrobiosis of marrow cells in irradiated rats are discussed in the presented works. Functional and morphological changes in kidneys and secretion glands in animals injected with ^{210}Po, x ray effects on the intramural plexus and solar plexus and reactions of internal organs of rats to chronic and early effects of fast neutron irradiation are discussed in the last group of articles. (R.V.J.)

12220 THE RELATIVE BIOLOGICAL EFFECT OF ^{252}Cf RADIATION ON HeLa CELLS IN CULTURE. Fairchild, R. G.; Drew, R. M.; Atkins, H. L. (Brookhaven National Lab., Upton, N. Y.). Radiology; 93: 1187-9(Nov 1969).

In order to determine the relative biological effect (RBE) of ^{252}Cf radiation, 110 needles containing about 4.5 μg ^{252}Cf each were arranged in such a way as to give a dose rate of 16.1 Rads/hr to the floor of a tissue culture flask containing the HeLa cells. A similar arrangement of radium needles was used providing a dose rate of 31 Rads/hr. The cell cultures were also x-irradiated acutely at a dose rate of 111 Rads/min. The D_0 values in the exponential regions of the resultant survival curves for the HeLa cells were 70 Rads for ^{252}Cf, 200 Rads for radium, and 164 Rads for acute x rays. The RBE of ^{252}Cf was 2.86 with respect to radium and 2.34 with respect to acute x-ray exposure. The potentials for the clinical application of ^{252}Cf are discussed and plans for future normal-tissue tolerance studies are given. (E.R.B.)

12221 RADIATION PROTECTION OF CULTURED MAMMALIAN CELLS. Vos, O. (National Defense Research Organization TNO, Rijswijk, Netherlands). pp 117-24 of Radiation Damage and Sulphydryl Compounds. Vienna; International Atomic Energy Agency (1969).

From Panel on Radiation Damage to the Biological Molecular Information System with Special Regard to the Role of Sh-Groups, Vienna, Austria. See CONF-681069.

The value and the present position of experiments with mammalian cells in tissue culture will be reviewed in the light of experimental work on chemical protection with higher and lower organisms. Most important observations that have been made in the field of radioprotection of cultured cells will be illustrated with various new examples. In this context the effect of concentration of the drug in the medium, time of exposure, structure of the SH compound, pH value of the incubation medium, influence of the cell cycle, and toxicity will be summarized. It will be stressed that extrapolation of data obtained at lower levels to higher levels may only be made if the criterion for irradiation damage is kept the same. The possibility of using early radiation effects such as single and double strand breakage in DNA as a parameter for radiation damage, and the importance of comparing such results with data obtained with phage DNA and pure biologically active DNA in vitro in order to evaluate the influence of the cellular environment will be discussed. (auth)

Invertebrates

Refer also to abstracts 12010, 12011, 12013–12015, and 12130.

12222 (UCRL-50717) EFFECT OF COBALT ON SEA URCHIN MORPHOGENESIS. Barrett, Mary M.; Timourian Hector (California Univ., Livermore. Lawrence Radiation Lab.). July 16, 1969. Contract W-7405-eng-48. 7p. Dep. CFSTI.

Embryos of the sea urchin Lytechinus pictus were incubated after fertilization in various concentrations of $CoCl_2$ in artificial seawater. At high concentrations (10^{-3} M), cobalt had a general toxic effect on development. At the low concentrations (10^{-4} M, 10^{-5} M), the effects of cobalt were mainly on the skeletal structures. Embryos removed from the cobalt solutions after 24 hr exposure were capable of normal development. Uptake of ^{60}Co did not take place during the early cleavage stages and reached an equilibrium at 35 hr. (auth)

12223 ANALYSIS OF RADIATION SENSITIVITY OF SILKWORM SPERMATOGONIA AND ITS IMPLICATIONS IN THE STUDY OF MUTATION. Tazima, Yataro (National Inst. of Genetics, Misima, Japan). pp 164-72 of Comparative Cellular and Species Radiosensitivity. /Bond, Victor P.; Sugahara, Tsutomu (eds.). Tokyo; Igaku Shoin Ltd. (1969).

From Conference on Comparative Cellular and Species Radiosensitivity in Animals, Kyoto, Japan. See CONF-680518.

Studies on cellular kinetics of γ-irradiated silkworm spermatogonia are briefly described and discussed with special reference to the mechanism of reversed dose-rate effect on mutation induction. A marked difference in sensitivity to killing was observed among spermatogonia at different developmental stages. However, the reversed dose-rate effect was not ascribable to this difference. Almost all secondary spermatogonia were killed after irradiation with 1,000R, regardless of the difference in sensitivity of the cells and in radiation dose rate. The number of surviving cells was almost the same after both acute and chronic exposure. The results indicated that for the consideration of mutation frequency almost all secondary spermatogonia could be ignored. The hypothesis of selective cell killing was thus completely ruled out. Instead, split-dose irradiation and cytological studies suggested a kind of synchronization effect, presumably consisting in an inhibition of the progress of cell cycle at a certain phase. The difference in mutation response between acute and chronic exposure can therefore be regarded as a difference between mutation rates at random and selected sensitivity phases of the cell cycle. (auth)

12224 VARIABLES IN THE RADIATION-ATTENUATION OF HELMINTH LARVAE: TEMPERATURE/OXYGEN EFFECTS. Fitzpatrick, B.; Mulligan, W. (Univ. of Glasgow). pp 17-19 of Isotopes and Radiation in Parasitology. Vienna; International Atomic Energy Agency (1968).

From Meeting on the Use of Isotopes and Radiation in Study and Control of Parasitic Diseases, Vienna, Austria. See STI/PUB-181; CONF-670738.

Experiments in the irradiation of Nippostrongylus brasiliensis larvae at different temperatures have shown a marked decrease of radiosensitivity with increasing temperature, particularly in the range of 20 to 30°C. This is probably due to an oxygen effect, i.e., a more rapid reduction of the oxygen content of the suspension at higher temperatures as a result of the greater metabolic activity of the larvae. Experiments where the oxygen content of the suspension was analyzed favor this theory. Further experiments are necessary to check if there is also a temperature effect per se, apart from the oxygen effect. Irradiation experiments with larvae should always be performed with temperature control, preferably within the range of 15 to 20°C, where the temperature effect is apparently insignificant. (auth)

12225 SOME PRACTICAL ASPECTS ON THE PRODUCTION OF RADIATION VACCINES AGAINST HELMINTHIC DISEASES. Prochazka, Z.; Tomanek, J. (Inst. of Veterinary Medical Research, Brno). pp 21-33 of Isotopes and Radiation in Parasitology. Vienna; International Atomic Energy Agency (1968).

From Meeting on the Use of Isotopes and Radiation in Study and Control of Parasitic Diseases, Vienna, Austria. See STI/PUB-181; CONF-670738.

The mortality rate of Dictyocaulus viviparus larvae increased much more rapidly on storage at room temperature than at 4°C. After one week of storage at room temperature it increased by 20%; at five weeks it amounted to 60%, which is 40% more than was found in the larval suspension held in the refrigerator. The invasiveness of Dictyocaulus viviparus larvae was also markedly affected by the temperature of storage. The larvae stored in the refrigerator (at +4°C) showed a significant decrease in invasiveness between the fourth and fifth weeks, whereas at room temperature the same decrease of invasiveness was observed between the second and fourth weeks. The viability and invasiveness for guinea pigs of larvae irradiated with 40 kR, and stored for five weeks, did not differ substantially from that shown by unirradiated larvae of the same age. A decrease in invasiveness was observed only shortly after irradiation (1.5 hours after irradiation) as shown by a significant decrease in larval counts recovered from the guinea pig lung three days after infection. At 24 hours after irradiation the invasiveness of the larvae reached the mean values obtained for infection with unirradiated larvae. Different exposures (280 R/min and 795 R/min) and different filtrations (0.5 mm Cu and 2.5 mm Al) had no significant effects upon the development of Dictyocaulus viviparus larvae in the guinea pigs, provided the same total dose of radiation was employed. (auth)

12226 RELATIVE ROLE OF EGGS AND ADULT WORMS IN DEVELOPMENT OF LIVER DAMAGE IN MICE INFECTED WITH SCHISTOSOMA MANSONI. Sadun, E. H.; Williams, J. S.; Witherspoon, C.; Martin, L. K. (Walter Reed Army Inst. of Research, Washington, D. C.). pp 43-58 of Isotopes and Radiation in Parasitology. Vienna; International Atomic Energy Agency (1968).

From Meeting on the Use of Isotopes and Radiation in Study and Control of Parasitic Diseases, Vienna, Austria. See STI/PUB-181; CONF-670738.

During the acute phase of S. mansoni infections, significant deviations in liver function tests were demonstrated and were related to egg deposition. Since exposure of cercariae to gamma irradiation has shown that a dose of 3000 rep prevents the developing worms from producing eggs, additional experiments were designed to determine whether relatively heavy worm loads without egg production would result in significant deviations in liver functions either before or after treatment. Mice were exposed to 10,000 cercariae which had been irradiated at 3000 rep and were divided into two groups. The animals of the first group were treated during the ninth week after exposure to infection and those of the second group were left untreated. At necropsy the worms recovered from both groups were stunted and there was no evidence of schistosome eggs in any of the organs of the mice. Infection with irradiated larvae produced only a transitory increase in transaminase levels (SGP-T and SGO-T) during the third week after exposure. No increases or significant group differences were observed in the transaminase values after the worms had reached adulthood. However, there was a significant increase in gamma globulin as infection progressed. These results indicate that the egg is the main pathogenic agent in schistosomiasis and add considerable evidence to the view that treatment can prevent the establishment of hepatic fibrosis. (auth)

12227 MORPHOLOGICAL CHANGES INDUCED BY ULTRAVIOLET RADIATION IN EGGS OF ASCARIDIA GALLI AND HETERAKIS GALLINARUM. Dubinsky, Pavel (Helmintologisches Institut, Kosice, Czech.). Biologia (Bratislava); 24: 595-600(1969). (In German).

The effect of monochromatic ultraviolet radiation on the eggs of Ascaridia galli and Heterakis gallinarum was studied. Damage to the cell nucleus, as indicated by irregular cleavage, occurred more frequently in Ascaridia galli. Contrariwise, damage to the protoplasm, as indicated by death of the embryo at an early stage of development, was observed more frequently in Heterakis gallinarum. Overall, eggs of Heterakis gallinarum are less radiosensitive than those of Ascaridia galli as judged by the survival rate of embryos. (H.B.G.)

12228 RESEARCH ON THE BIOLOGICAL ACTION OF NATURAL RADIATION: STUDY OF THE GROWTH OF PARAMECIUM AURELIA AND PARAMECIUM CAUDATUM IN SUBTERRANEAN LABORATORIES. Planel, Hubert; Soleihavoup, Jean-Pierre; Cottin, Francis; Tixador, Rene; Richoilley, Gerard (Faculte de Medecine, Toulouse. Faculte des Sciences, Toulouse). Compt. Rend., Ser. D; 269: 1697-1700(29 Oct 1969). (In French).

Experiments were conducted on cultures of Paramecium aurelia and P. caudatum in a subterranean laboratory of C. N. R. S. at Moulis, Ariege; this can be considered a natural device for radioprotection. For each experiment three groups of 15 to 20 cultures were placed in a surface laboratory, in an underground gallery with dolomite walls (G1), and in an underground gallery with an argil (clay) foundation (G2). The two underground galleries were covered with 200 m of rock. The intensity of natural radiation was determined with a scintillation counter. The growth of Paramecium cultures was diminished in the underground laboratories, the decrease being more marked in G1 than in G2. Although the rock wall served as a protection against cosmic radiation, this was counteracted by a telluric radioactivity from the radioactive elements in the wall of the gallery. Graphs are presented to show results. (H.L.W.)

Vertebrates

Refer also to abstracts 11909, 11944–11949, 11951, 11953, 11956, 11963, 11964, 11971, 11979–11983, 11985–11988, 11990–12009, 12016, 12017, 12053, 12105–12112, 12114, 12115, 12118, 12127, 12129, 12131–12133, and 12196.

12229 (ORO–672) ANNUAL PROGRESS REPORT, JANUARY 1–DECEMBER 31, 1968. (UT–AEC Agricultural Research Lab., Oak Ridge, Tenn.). Oct. 1969. Contract AT-40-1-GEN-242. 191p. Dep. CFSTI.

Thirty separate abstracts were prepared for inclusion in NSA. These fall in the general groups: prenatal studies, reproduction, late effects, early effects, metabolism, soil chemistry, and plant studies. In addition reports on the laboratory herd health and pathology are included. A list of publications is provided. (C.O.)

For abstracts of individual papers see: 11508, 11694, 11908–11911, 11974, 12040–12043, 12213, 12214, 12230–12241, 12318–12320, 13692, and 13693.

12230 (ORO–672, pp 3-11) SOMATIC CHANGES IN THE FETUS. Murphree, R. L. (UT–AEC Agricultural Research Lab., Oak Ridge, Tenn.).

Findings in studies relative to the effects of prenatal ^{60}Co γ irradiation on development of lambs, rats, and swine are briefly reviewed and results of different dose-rate studies are presented. Eye damage was investigated in rats, the mortality rate was determined for lamb fetuses, and deformities were assessed in swine. The highest percentage of rats showed eye damage at a dose rate of 3 R/min, and irradiation at 1R/min (188 R dose) significantly increased the frequency of deformed lambs as compared to a rate of 47 R/min ($P < 0.005$; chi-square = 9.11). Sufficient numbers of swine litters were not examined to yield quantitative results; however, photographs are included in the report. (C.O.)

12231 (ORO–672, pp 12-20) EFFECT OF PRENATAL IRRADIATION OF RATS ON GROWTH. Martin, Polly G. (UT–AEC Agricultural Research Lab., Oak Ridge, Tenn.).

The effect of γ radiation on prenatal growth of rats was investigated at the subcellular level. Results indicated that the differences in weights of four organs (liver, kidney, spleen and thymus) were due to fewer cells in the tissues of the irradiated rats and not to differences in cellular material (DNA, RNA, and protein). Mean body weights of prenatally irradiated male rats (160 R, 1, 2, 3.3, 5, and 10 R/min on the 18th day of gestation) expressed as % of control revealed that rats irradiated with 3.3 R/min weighed less at 30 days than any other group. The weight levels of other groups paralleled the fluctuation in mean body weight of that of the 3.3 R/min group. (C.O.)

12232 (ORO–672, pp 34-9) LIFETIME REPRODUCTION HERD. Reynolds, R. A. (UT–AEC Agricultural Research Lab., Oak Ridge, Tenn.).

An analysis was made of the factors affecting calving intervals for the years 1961 through 1968. Factors considered were previous ^{60}Co γ irradiation, source of dam, age of dam, previous parity of dam, sex of current calf, current calf's performance traits, and sire of calf. Previous parity had the most pronounced effect on calving; females pregnant the previous year had a decrease in calving interval. Cows with calves with the highest daily gain had a shorter calving interval while cows with calves having a higher condition score had a longer calving interval. Six of the nine animals that died during the report period are discussed in the necropsy report. (C.O.)

12233 (ORO–672, pp 43-61) LATE EFFECTS OF IRRADIATION IN LARGE ANIMALS. Brown, D. G.; Johnson, D. F. (UT–AEC Agricultural Research Lab., Oak Ridge, Tenn.).

Progress is reported on studies concerned with several groups of large animals being maintained throughout their life span to determine and evaluate late manifestations of radiation effects. The groups included burros (whole-body γ-irradiation effects) and burro foals, adult burros (bomb radiation effects), adult burros (neutron radiation effects), swine (mixed neutron-γ bomb radiation effects), and sheep (Ra and Sr toxicity). Clinical and pathological manifestations of irradiated swine are compared to those of burros. (C.O.)

12234 (ORO–672, pp 62-3) LATE EFFECTS OF WHOLE-BODY GAMMA IRRADIATION ON THE WORK PERFORMANCE AND RELATED PHYSIOLOGY OF SHETLAND PONIES. Brown, D. G. (UT–AEC Agricultural Research Lab., Oak Ridge, Tenn.).

The physical fitness of 8 pairs of Shetland ponies, one-half of which were γ-irradiated, was evaluated by subjecting the ponies to work assignments and measuring various physiological changes that occurred during the work. Differences that appeared to be evident were heart rate (slower in irradiated animals), respiratory rates and rectal temperatures during work (higher in irradiated animals) and differences in lymphocyte count (lower in irradiated animals). (C.O.)

12235 (ORO–672, pp 66-7) SUBSTANCES FORMED BY IRRADIATION ACTION ON ANIMALS. Souto, J. C. (UT–AEC Agricultural Research Lab., Oak Ridge, Tenn.).

Of five different substances found in the urine of irradiated sheep, but not detectable by the same procedure using urine from nonirradiated sheep, three were studied using infrared spectroscopy, mass spectroscopy, gas chromatography, and vapor pressure osmometry. Each of the three compounds was identified as a saturated, branched-chain, monocarboxylic aliphatic acid; the compounds differed in length and branching of the chains. (C.O.)

12236 (ORO–672, pp 68-9) EFFECT OF MINUTE INTENSITY OF ^{60}Co-GAMMA RADIATION ON THE MORTALITY OF SWINE. Brown, D. G. (UT–AEC Agricultural Research Lab., Oak Ridge, Tenn.).

The $LD_{50/30}$ for Duroc swine at various minute intensities (dose rate) while minimizing other variables as much as was feasible was determined using 150 pigs. The $LD_{50/30}$ values calculated were 674, 425, and 375 R, respectively for 1, 10, and 50 R/min. The relative effectiveness of 10 R/min was 1.6 and 50 R/min was 1.8, where 1 R/min was assigned the value of 1. The relative effectiveness of γ dose rate on depression of leukocyte and platelet count appeared to be similar to mortality. (C.O.)

12237 (ORO–672, pp 70-2) EARLY EFFECTS OF 14 MeV NEUTRON IRRADIATION IN SWINE. Brown, D. G. (UT–AEC Agricultural Research Lab., Oak Ridge, Tenn.).

The effects of 14-MeV neutrons on the general clinical changes, hematology, leukocyte cultures, mortality, and gross and microscopic pathology manifested in swine were studied. Whole-body doses were 200, 400, and 600 rads at a dose rate of 10 R/min. Results observed were similar to those previously described in swine that succumbed to γ radiation. (C.O.)

12238 (ORO–672, pp 73-7) SIMULATED FALLOUT EFFECTS ON LIVESTOCK. Bell, M. C.; Sasser, L. B.; West, J. L.; Wade, L. (UT–AEC Agricultural Research Lab., Oak Ridge, Tenn.).

The effects of ingesting non-absorbable fallout simulant by grazing sheep and the interaction of whole-body γ irradiation with β irradiation of skin and β irradiation of the gastrointestinal tract were investigated. The first phase of the study was the establishment of acute levels of feeding ^{90}Y fallout simulant. Results are presented in tabular form; in general, clinical signs manifested were anorexia and diarrhea. (C.O.)

12239 (ORO–672, pp 78-81) PATHOLOGY. Johnson, D. F.; West, J. L. (UT–AEC Agricultural Research Lab., Oak Ridge, Tenn.).

Necropsy reports on bovine (5), ovine (6), and porcine (2) animals that were long-term survivors of ionizing radiation are presented. Outstanding pathological manifestations relative to the necropsies were incorporated into the reports. (C.O.)

12240 (ORO–672, pp 87-92) RADIOIODINE AND DAIRY CATTLE. Miller, J. K. (UT–AEC Agricultural Research Lab., Oak Ridge, Tenn.).

Effects of graded levels of ^{131}I irradiation injury on iodine

metabolism, growth, reproduction, lactation, and milk composition of dairy cattle were studied; 9 identical twin dairy heifers were used. The status of results of these areas under investigation are summarized and data are presented in graphic and tabular form. Thyroid gland activity and depression of milk yield showed similar levels at the higher dose rates. (C.O.)

12241 (ORO-672, pp 105-6) EFFECT OF WHOLE BODY GAMMA RADIATION IN EGG PRODUCTION AND MORTALITY IN THE WHITE LEGHORN CHICKEN, COTURNIX QUAIL, AND BOBWHITE QUAIL. Mraz, F. R. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

Two hundred birds each of White Leghorn chickens (WL), Coturnix quail (C), and Bobwhite quail (BW) were irradiated at 2 weeks of age; an additional 180 WL, 240 C, and 400 BW were γ irradiated at maturity using dose rates of 5, 25, or 45 R/min. The C females were more resistant with virtually no mortality at any of the exposure levels, and the WL ($LD_{50/30}$ was between 800 and 1000 R) were more resistant than the BW ($LD_{50/30}$ was about 1300 R). The effects of radiation on egg production suggested a similar pattern to mortality. It was concluded that a definite difference in radiosensitivity exists among the three avian species tested. (C.O.)

12242 (STI/PUB-186) EFFECTS OF RADIATION ON CELLULAR PROLIFERATION AND DIFFERENTIATION. Proceedings Series. Proceedings of a Symposium held in Monaco, 1-5 April 1968. (International Atomic Energy Agency, Vienna (Austria)). Aug 1968. 570p. (In several languages). (CONF-680413). IAEA $13.50.

Separate abstracts were prepared for 35 of the 40 papers presented at this symposium. The other five papers appeared previously in NSA as abstracts-22: 38189, 22: 38200, 22: 49491, 22: 52036, and 23: 24721. The papers are presented in five major groups based on subject matter. These groups include: biochemical considerations of injury and repair; hematopoietic stem cells-relationships and kinetics; hematopoiesis-growth and differentiation; lymphopoiesis and the immune response; and proliferative response of other mammalian systems-tumor cells and intestinal cells. Discussions are included at the end of each paper. A list of participants and an author index are also included. (E.R.B.)

For abstracts of individual papers see: 11894-11896, 11951-11953, 11980-11983, 12106, 12107, 12133, and 12243-12264.

12243 PROSPECTS IN THE STUDY OF STEM-CELL KINETICS. Till, J. E. (Univ. of Toronto, Ont. Ontario Cancer Inst., Toronto). pp 117-25 of Effects of Radiation on Cellular Proliferation and Differentiation. Vienna; International Atomic Energy Agency (1968).

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco. See STI/PUB-186; CONF-680413.

The recent rapid progress in the field of stem-cell kinetics was due in large part to the development of reliable in vivo assays for the functions of hemopoietic stem cells. As a direct result of the availability of these assays, several novel and interesting phenomena were described. What is now needed is not so much further search for new phenomena as an understanding of the phenomena that are already known. It is postulated that new approaches will be required for the analysis of these phenomena, and that future progress in the field will be strongly dependent on the development of methods suitable for the detailed study of the growth and differentiation of populations of hemopoietic cells in culture systems. (auth)

12244 FUNCTIONAL STATE OF HAEMOPOIETIC STEM CELLS IN THE IRRADIATED MOUSE. Silini, G.; Pozzi, Laura V. (Centro Studi Nucleari, Casaccia, Italy). pp 127-38 of Effects of Radiation on Cellular Proliferation and Differentiation. Vienna; International Atomic Energy Agency (1968).

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco. See STI/PUB-186; CONF-680413.

The repopulation kinetics of bone marrow in irradiated (C3H × C57BL)F_1 hybrid mice were followed at different time intervals after a single whole-body dose of 150 rad rays. The changes in the number of total nucleated cells and of colony-forming cells were estimated and expressed as number of cells per femur shaft of fixed length. For the evaluation of the progenitor cell compartment, an exogenous test of transplantation into heavily irradiated hosts followed by spleen colony counts was employed. In an attempt to distinguish between cycling and dormant cells in the progenitor pool, vinblastine was also administered under various schedules of treatment with respect to time and dosage to follow the changes induced by this drug in the irradiated recovering marrow. The depopulation of total bone-marrow cells caused by vinblastine proceeded at a comparable rate in both the irradiated and the normal mouse. On the other hand, depopulation of the colony-formers is faster in animals irradiated 1 to 2 days previously as compared with normal animals or mice irradiated 1 week of 2 weeks earlier. The data were interpreted to show that in the marrow of a newly-irradiated animal more cells are in a fast cycle than in a normal or a recovering animal. Data are finally presented and discussed concerning the use of vinblastine for studies of stem-cell kinetics in hemopoietic tissues. (auth)

12245 KINETICS OF MULTIPLICATION AND DIFFERENTIATION OF HAEMOPOIETIC PROGENITOR CELLS TRANSPLANTED INTO IRRADIATED MICE. Pozzi, Laura V.; Silini, G. (Centro Studi Nucleari, Casaccia, Italy). pp 139-48 of Effects of Radiation on Cellular Proliferation and Differentiation. Vienna; International Atomic Energy Agency (1968).

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco. See STI/PUB-186; CONF-680413.

The growth of colony-forming units (CFU) was followed in the spleen of normal, polycythemic, and polycythemic erythropoietin-treated test mice after whole-body x irradiation and normal bone-marrow inoculation. The number of CFU was estimated at various time intervals after inoculation of bone-marrow by retransplantation of the test spleens in irradiated mice. The results indicate that in the spleen of polycythemic animals the number of CFU is the same as in the normal animals up to day 4 after bone-marrow inoculation. At later times the content of CFU per spleen is about half of that in normal animals, although the CFU growth rate from day 6 to day 9 is comparable in both normal and polycythemic animals. Erythropoietin injected daily in polycythemic animals from day 3 after bone-marrow inoculation brings the CFU growth curve back to the level of normal animals. The 7-hr uptake of ^{59}Fe in the spleen of normal, polycythemic, and polycythemic EPO-treated irradiated animals, at various times after bone-marrow inoculation, was also followed as a measure of CFU erythropoietic differentiation. The results are discussed in the light of the available information concerning growth and differentiation of spleen colony-formers. (auth)

12246 REPOPULATION OF THE STEM-CELL COMPARTMENT IN HAEMOPOIETIC AND LYMPHATIC TISSUES OF MICE AFTER X-IRRADIATION. Vos, O. (National Defense Organization, TNO, Rijswijk, Netherlands). pp 149-62 of Effects of Radiation on Cellular Proliferation and Differentiation. Vienna; International Atomic Energy Agency (1968).

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco. See STI/PUB-186; CONF-680413.

Repopulation in hemopoietic tissues of mice was studied at various times after irradiation with a sublethal x-ray dose of 460 R and after exposure to a lethal x-ray dose of 800 R followed by transplantation of 4×10^6 syngeneic bone-marrow cells. The number of stem cells was determined with the exogenous and endogenous spleen colony technique in the bone-marrow of the femur and in the spleen. Repopulation in lymphatic tissues was investigated at various times after sublethal irradiation with 460 R, sublethal irradiation with 460 R followed by allogeneic skin transplantation, lethal irradiation with 800 R followed by transplantation of 2×10^6 syngeneic bone-marrow cells, and irradiation with 800 R followed by transplantation of 2×10^6 and 5×10^6 syngeneic bone-marrow and lymph node cells, respectively. The number of stem cells was estimated in the spleen and in lymph nodes with a technique based on a graft-versus-host reaction. The results showed that a rapid repopulation occurred in hemopoietic tissues under all circumstances. In the spleen an overshoot was found during a period beginning shortly after the 7th day and lasting for some weeks. In lymphatic tissues repopulation by stem cells was slow. During the first one or two weeks some decrease was even observed. This was followed by a slow repopulation that around 100 days after irradiation reached a level slightly below that found in control animals. Small differences of repopulation in the various organs and under different circumstances are discussed. It was postulated that immunocompetent lymphatic stem cells (antigen-sensitive cells or PC_1 cells) do not proliferate or do so only to a limited extent. This compartment must be replenished by repopulation of differentiating stem cells from the bone marrow. It seems probable that stem-cell depletion or antigenic stimulation has only a marginal effect upon repopulation. (auth)

12247 CHARACTERIZATION OF THE STEM-CELL POPULATION OF PHENYLHYDRAZINE-TREATED RODENTS. Hodgson, G.; Guzman, E.; Herrera, C. (Univ., Chile, Santiago). pp 163-72 of Effects of Radiation on Cellular Proliferation and Differentiation. Vienna; International Atomic Energy Agency (1968).

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco. See STI/PUB-186; CONF-680413.

The content of stem cells in the spleen, blood, and bone marrow of mice treated with phenylhydrazine was studied. The experimental method used was transplantation in lethally irradiated mice. There was a marked increase in the content of stem cells in liver and blood and a small increase in bone marrow in the case of animals treated with phenylhydrazine. Judging by the effects of vinblastine, about 80% of the stem cells of spleen pass through mitosis within 24 hours, while only 20% of the marrow cells and none of the blood stem cells pass through mitosis within this period. To obtain information on the average residence time of stem cells in blood, bone marrow was injected intravenously into normal rats and the blood content was determined at intervals. A disappearance half-life of 6 min was found. To estimate the increase in the number of stem cells in the spleen of animals treated with phenylhydrazine, rats with and without spleen were γ-irradiated with 500 rad (^{137}Cs) after being given five phenylhydrazine injections. The rats without spleen developed severe anaemia with high mortality (70%), compared with the rats with spleen. Among the survivors, erythropoiesis started to recover later and proceeded more slowly in rats that had undergone splenectomy than in those with spleen. Transfusion corrected the anaemia in the rats without spleen and reduced the high mortality, but did not alter the rate of erythropoiesis recovery. The spleen plays an important part in erythropoiesis and the bone-marrow function recovers sooner in rats with spleen than in those without. Although the spleen is important for erythropoiesis recovery after irradiation preceded by treatment with phenylhydrazine, it has no effect on recovery after irradiation alone. It seems as though the spleen is required when proliferation of stem cells at the maximum rate is essential for survival. It is possible that the spleen constitutes a favorable local environment for the proliferation of stem cells. (auth)

12248 RECOVERY OF THE ERYTHROPOIETIN-SENSITIVE STEM-CELL POPULATION FOLLOWING TOTAL-BODY X-IRRADIATION. Byron, J. W. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). pp 173-85 of Effects of Radiation on Cellular Proliferation and Differentiation. Vienna; International Atomic Energy Agency (1968).

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco. See STI/PUB-186; CONF-680413.

Erythropoietin acts on hemopoietic stem cells to initiate their differentiation into the erythroid series. This effect may be used in polycythemic mice to estimate changes in the erythropoietin-sensitive stem-cell population following whole-body x irradiation (WBR). Generally, single doses of erythropoietin, less than that needed for maximum stem-cell response, are used to estimate changes in the stem-cell population. The validity of results using this test is based upon accepting several assumptions regarding erythropoietin kinetics. These are: the contribution of endogenous erythropoietin is always negligible; the origin of the dose-response curve to erythropoietin alters only because of changes in stem-cell numbers; the proportion of stem cells responding to a given concentration of erythropoietin is independent of stem-cell numbers; the slope of the dose-response curve does not alter; and competition between erythropoietin and other factors for the stem cells remains unchanged. The studies to be reported indicate that some of these assumptions may not always be valid. Following 150 rad WBR, changes in erythropoietin dose-response curves were not always due to changes in the size of the stem-cell population, but also due to changes in erythropoietin kinetics. Changes in erythropoietin kinetics could be corrected by using doses of erythropoietin that at any particular time after WBR gave maximum stem-cell response; through full dose-response studies, the nature of changes in erythropoietin kinetics following WBR could be established. These studies appear to explain discrepancies in results obtained in different laboratories using the erythropoietin test. The effect of 150 rad WBR on the erythropoietin-sensitive stem-cell population is an initial depression within 30 min to 20% of normal followed by a second depression (post-irradiation dip) at about 12 hr. Twenty-four hr after WBR there is a recovery to the initial depression. This level is maintained up to at least 72 hr after WBR. By eight days, the population recovers to preirradiation levels. This appears to be maintained up to 14 days after WBR without the previously reported overshoot of the erythropoietin-sensitive stem-cell population. (auth)

12249 KINETICS OF CIRCULATING HAEMOPOIETIC COLONY-FORMING UNITS IN THE MOUSE. Hellman, S.; Grate, Helen E. (Yale Univ., New Haven). pp 187-96 of Effects of Radiation on Cellular Proliferation and Differentiation. Vienna; International Atomic Energy Agency (1968).

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco. See STI/PUB-186; CONF-680413.

The premise that hemopoietic stem cells can migrate through the bloodstream and serve to repopulate bone-marrow spaces whose proliferative cells were destroyed by radiation is well supported. It was previously demonstrated that the leucopenia produced by partial body radiation is more profound in animals when the duration of radiation is prolonged. This was interpreted as due to destruction of a greater number of migrating stem cells during the more protracted radiation exposure. The number of colonies found in the spleens of mice irradiated at varying dose rates with hind limb shielded supported this notion. The more protracted exposure resulted in fewer colonies. These results imply that the repopulation of irradiated marrow is due to a limited pool of stem cells having a ready access to the vascular space and having the ability to migrate and seed the depopulated areas. Prolonged partial-body exposure destroys a significant proportion of such cells. The data presented give evidence of such a compartment. Mice were irradiated with hind-limb shielding. This limb was subsequently irradiated at varying times thereafter. The number of spleen colonies formed gives an estimate of the number of colony-forming units migrating from the shielded limb into the irradiated spleen during the time between the exposures. The results reveal an initial rapid migration rate that progressively decreases. This indicates a limited pool of cells having easy interchange with the vascular space. This compartment is rapidly depleted and further influx of cells from the shielded limb during longer periods between exposures is at a markedly reduced rate. The number of colony-forming units in the shielded marrow was determined as was the number in the peripheral blood. From this data the size and distribution of this mobilizable pool were estimated. This pool size was 0.3% of the total CFU population of which $\frac{1}{3}$ are in the peripheral blood at any one time. (auth)

12250 NON-IMMUNE FACTORS AFFECTING THE PROLIFERATION OF HAEMOPOIETIC CELLS IN IRRADIATED MICE. Zeleny, V.; Lengerova, Alena (Inst. of Experimental Biology, Prague). pp 197-204 of Effects of Radiation on Cellular Proliferation and Differentiation. Vienna; International Atomic Energy Agency (1968).

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco. See STI/PUB-186; CONF-680413.

The proliferation capacity of intact hemopoietic cells injected into γ-irradiated mice was investigated, as it depends on the differences between the genotypes of host and donor. The determination of spleen colony-forming capacity in sub-lethally irradiated animals was used as a measure of the proliferative ability of injected cells in syngeneic and non-syngeneic host environments. Mice of strictly inbred congenic strains of a common genetic background (C57BL/10 ScSn) were used as the syngeneic and non-syngeneic recipients, so that the differences could be reduced to different allelic substitutions at a single histocompatibility locus. It was found that the potential colony-forming capacity, as manifested in a syngeneic combination, was reduced in a non-syngeneic environment. The degree of reduction was similar, whether the system differed at strong (H-2) or weak (H-1 or H-3) histocompatibility loci; no straight parallelism could therefore be found with the immune mechanism of incompatibility. A mutual similarity of genotypes of both the host and donor is required for the full manifestation of colony-forming capacity, as demonstrated by using the parental strains and their F_1 hybrid combinations. The possible bearing of these findings on allogeneic inhibition is discussed. (auth)

12251 FEED-BACK REGULATION OF HAEMOPOIESIS. Feldman, M. (Weizmann Inst. of Science, Rehovoth, Israel). pp 223-34 of Effects of Radiation on Cellular Proliferation and Differentiation. Vienna; International Atomic Energy Agency (1968).

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco. See STI/PUB-186; CONF-680413.

Studies are reported on the feed-back regulation of erythropoiesis by means of the intrasplenic cloning system of hemopoietic cells. Polycythemia, produced by passive transfusion by syngeneic, allogeneic, or xenogeneic red blood cells, inhibited the formation of bone-marrow derived erythroid clones. Polycythemia also inhibited the formation of erythroid clones of endogenous stem cells. Oxygen overloading was found to be a necessary factor in the suppression of erythroid clone formation: no suppression of erythroid colonies was observed when polycythemic animals were kept under hypoxic conditions. Erythropoietin, either of exogenous or of endogenous origin, elicited a reformation of erythroid clones in suppressed animals. Studies on the kinetics of reformation of erythroid clones after the administration of erythropoietin suggested that the colony-forming stem cell can

replicate a few times in the absence of erythropoietin and the cell progeny thus formed are the target cells for erythropoietin action. If, indeed, the colony-forming cell replicates in the absence of the specific inducer, then the cells thus formed should themselves be stem cells. This was substantiated by demonstrating that the cloning efficiency of spleens of polycythemic recipients was higher than that of non-polycythemic animals. Experiments indicating that erythroid clones produced by erythropoietin in polycythemic animals disappeared after the discontinuance of erythropoietin application demonstrated the distinction between the mitogenic and the morphogenetic effects of erythropoietin. The latter seemed to be operated by an early transcription of RNA for proteins necessary for the complete maturation of the red blood cell. Erythroid clones produced by fetal hemopoietic stem cells seemed to be regulated by a different mechanism from that which controls the formation of bone-marrow derived clones. Clones produced by fetal cells were only partially suppressed in the polycythemic recipients. (auth)

12252 CHANGES IN PROLIFERATION RATE AND MATURATION TIME OF ERYTHROID PRECURSORS IN RESPONSE TO AN ANAEMIA AND IONIZING RADIATION. Blackett, N. M. (Inst. of Cancer Research, Belmont, Eng.). pp 235-46 of Effects of Radiation on Cellular Proliferation and Differentiation. Vienna; International Atomic Energy Agency (1968).

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco. See STI/PUB-186; CONF-680413.

The cell population kinetics of the erythroid system were studied by means of suicide methods with methotrexate and tritium-labeled thymidine (^{3}H-Th), and autoradiographic methods with ^{3}H-Th and ^{55}Fe. These experiments provided estimates of the proliferation rate of two distinct populations of unrecognized erythroid cells and the proliferation rate and time of maturation of cells as they pass through the recognizable erythroid stages. With these methods it was found that in response to anemia there is an increase in the cell proliferation rate of the recognizable erythroid cells and in unrecognized cells immediately preceding the recognizable cells, but with no change in the proliferation rate of the earlier cells that are responsible for repopulating the marrow of bone-marrow depleted hosts. In response to continuous γ irradiation there is a marked increase in proliferation of the repopulating bone-marrow cells, but little change in the proliferation rate of later stages. However, there is an increase in maturation time that leads to extra cell divisions as cells mature through the recognizable stages. The role of erythropoietin in producing increased proliferation and more rapid maturation is discussed. (auth)

12253 DISTRIBUTION OF CELL CYCLE TIMES OF NORMOBLASTS IN THE BONE MARROW OF NORMAL AND CONTINUOUSLY IRRADIATED RATS. Lord, B. I. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). pp 247-57 of Effects of Radiation on Cellular Proliferation and Differentiation. Vienna; International Atomic Energy Agency (1968).

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco. See STI/PUB-186; CONF-680413.

In investigating the proliferative capacity of red blood-cell precursors in rat bone marrow, the distribution of cell cycle times in the erythroid compartments was determined both for normal rats and for rats maintained under a regime of continuous whole-body γ irradiation. Frequently repeated injections of tritium-labeled thymidine were used to label all cells in cycle as they entered the DNA synthesis phase, the label being repeated at intervals of 4 or 5 hr to minimize the number of cells escaping the label. After about 55 hr of such labeling, virtually all cells in the erythroid maturation sequence were found to be labeled. The increased labeling index over this period of time was followed for the pronormoblasts, early normoblasts and intermediate normoblasts. The same observations were also carried out in rats that were exposed continuously to 84 rad of γ radiation daily for 15 days. Under these conditions, 100% labeling was reached in 25 hr. A method is described for analyzing the changing slopes of the repeated labeling curves and, thereby, obtaining a distribution of cycle times for the cells under investigation. With this method, it was possible to define a distribution of the proliferating erythroid cells as a whole in both the normal and irradiated animals. A very widely spread distribution having the following characteristics: minimum cycle time 9 hr, mode 20 hr, mean 33 hr, and maximum about 75 hr was found in the normal animals. After irradiation the distribution was narrowed with the following characteristics: minimum cycle time 8 hr, mode 12 hr, and maximum about 55 hr. (auth)

12254 MATHEMATICAL MODEL FOR POST-IRRADIATION HAEMOPOIESIS. Okunewick, J. P.; Kretchmar, A. L. (RAND Corp., Santa Monica, Calif. Oak Ridge Associated Universities, Tenn.). pp 259-73 of Effects of Radiation on Cellular Proliferation and Differentiation. Vienna; International Atomic Energy Agency (1968).

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco. See STI/PUB-186; CONF-680413.

A model for hemopoiesis was constructed based on the following hypothesis: Hemopoietic stem cells have the capability of either reproducing as stem cells or differentiating into specialized blood cells of at least two different types; the size of the stem-cell compartment is in part regulated by the rate of increase due to stem-cell reproduction and in part by the rate of loss of stem cells through differentiation; in addition, the size of the stem-cell compartment is in part regulated by a competitive cell-to-cell interaction between the stem-cells themselves and between the differentiating cells and the stem-cells, such that the presence of an exceptionally large number of either cell type would have a repressive effect on the rate of increase of the stem-cell population. This model was applied to the post-irradiation erythropoietic behavior of the rat. In the computer studies with the model, an x-ray dose sufficient to inhibit reproduction in 50% of the erythroid stem cells was assumed. It was also assumed that reproduction and differentiation are genetically separately controlled processes and that, therefore, some part of the reproductively injured cells were still capable of differentiation. Under these conditions the model predicted an abortive rise in reticulocyte number; peaking at about 6 days. True recovery was predicted to occur at about 16 days. Both the abortive rise and the true recovery were also present in those segments of the model representing earlier erythroid cells, occurring at progressively earlier times in progressively more primitive cells. Comparison of the model's predictions with experimentally obtained data for post-irradiation erythroid recovery showed a good agreement both with respect to the time of the abortive peak and the time of true recovery. (auth)

12255 LYMPHOID PRECURSOR CELLS AND THEIR DIFFERENTIATION. Chertkov, I. L. (Central Inst. of Haematology and Blood Transfusion, Moscow); Fridenshtein, A. Ya. pp 285-306 of Effects of Radiation on Cellular Proliferation and Differentiation. Vienna; International Atomic Energy Agency (1968). (In Russian).

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco. See STI/PUB-186; CONF-680413.

Present-day ideas concerning precursor cells in lymphoid tissues are discussed and it is suggested that the stem cells' decision in regard to proliferation and the path of further differentiation may be a multi-stage process, occurring at various successive phases in the histogenesis of lymphoid cells. It is proposed that only those elements that are capable of actively deciding (under the influence of suitable stimuli or factors inherent in the cell) in which direction the successor cells are to differentiate should be regarded as precursor cells. It is shown that there are in lymphoid tissue at least three stages with the properties of precursor cells; the stem hemopoietic cell, the antigen-sensitive cell, and the immunological memory cell. It is suggested that the working cells of immune response are transformed into immunological memory cells. The morphological characteristics of the precursor cells are also discussed. (auth)

12256 EFFECT OF IRRADIATION ON THE TWO POPULATIONS OF SMALL LYMPHOCYTES. Ruhenstroth-Bauer, G.; Luecke-Huhle, Christine (Max-Planck-Inst. fuer Biochemie, Munich). pp 327-36 of Effects of Radiation on Cellular Proliferation and Differentiation. Vienna; International Atomic Energy Agency (1968).

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco. See STI/PUB-186; CONF-680413.

Experimental results are in agreement with the hypothesis that the small lymphocytes of the rat comprise, in fact, two cell populations, the A and B lymphocytes. The mean electrophoretic mobility of the A lymphocytes is $-0.930 \pm 0.050 \times 10^{-4}$ ($cm^2\ s^{-1}V^{-1}$) and their mean volume $196 \pm 24\ \mu m^3$. The mean electrophoretic mobility of the B lymphocytes is $-1.060 \pm 0.066 \times 10^{-4}$ ($cm^2\ s^{-1}V^{-1}$) and their mean volume $141 \pm 28\ \mu m^3$. In the thoracic duct these types normally occur in an approximately 20:80 mixture, but after 800 R of x radiation the duct population contains almost only B lymphocytes. Splenectomized animals show no alteration in the normal distribution of A- B cells in the thoracic duct after irradiation. The blood of normal rats contains almost exclusively A-type lymphocytes. After irradiation, a dose-dependent increased number of B lymphocytes occurs in the bloodstream, while the A lymphocytes are very greatly diminished in number. An injec-

tion of ethanol likewise causes a rapid appearance of B lymphocytes in the peripheral blood. With the aid of the Jerne technique, a correlation was shown between the proportion of A lymphocytes in the total leukocyte population and the number of cells responding immunologically to sheep erythrocytes. (auth)

12257 NEW APPROACH TO STUDYING THE DIFFERENTIATION PROCESSES OF LYMPHOID CELLS UNDER X-IRRADIATION. Beran, M. (Veterinary Research Inst., Prague); Pospisil, M.; Pospisil, J. pp 337-47 of Effects of Radiation on Cellular Proliferation and Differentiation. Vienna; International Atomic Energy Agency (1968).

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco. See STI/PUB-186; CONF-680413.

Many of the difficulties in the interpretation of in vivo effects of x irradiation may be circumvented by the use of an in vitro system. At present, however, a completely in vitro system is not readily available for irradiation studies. To create a culture system that would permit proliferation of cultivated cells and investigation of cellular changes under different conditions, a chamber employing a continuous flow of blood plasma from an extracorporeal circuit in experimental animals was constructed. Such a system also made it possible to investigate a specific lymphoid cell population after x irradiation, avoiding the indirect effects associated with whole-body irradiation of the organism. The culture system employed membrane filters (porosity 0.1 to 0.3 μm) that allowed the plasma to pass from the extracorporeal blood circulation into the culture chamber for nourishment. The filters permitted free diffusion of all low and high molecular weight plasma substances, but excluded all cells. The cultured cells and plasma medium were maintained for up to 10 days for experimental analysis. In this system, the lymphoid cells not only survived but proliferated and underwent mitosis, as was established by means of cytological and autoradiographic analysis. Measurements of the degree of x-radiation injury to the proliferative capacity of allogeneic lymphoid cells from the cervical lymph nodes of goats were performed. The response of lymphoid cells to antigenic stimulation (bacteriophage ϕX 174) was employed as an index of their ability to differentiate after exposure to various doses of x irradiation. Different degrees of cellular injury in the lymphoid population developed as a function of the radiation dose. For example, with 200 rad, antigen stimulation 5 hr later very strongly stimulated blastogenesis. Mitotic activity first appeared 11 hr after exposure. Control lymphoid cultures, stimulated antigenically, showed other differential parameters. Higher doses of x irradiation produced even greater damage. (auth)

12258 EFFECT OF IRRADIATION ON THE KINETICS OF CELLULAR PROLIFERATION IN ANIMAL AND HUMAN TUMOURS. Tubiana, M.; Frindel, E.; Malaise, E. (Institut Gustave Roussy, Villejuif, France). pp 423-52 of Effects of Radiation on Cellular Proliferation and Differentiation. Vienna; International Atomic Energy Agency (1968). (In French).

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco. See STI/PUB-186; CONF-680413.

The kinetics of cellular proliferation in tumors is governed by three main factors, the average duration of the cell cycle, the growth fraction, and cell losses. The effect of the last-mentioned factors is the main reason for the variations in rate of growth among solid tumors and for the slackening in the rate of growth observed in a solid tumor as its volume increases. In ascitic tumors, the duration of the cell cycle increased considerably during tumor growth. When a cell is transplanted in the form of an ascitic tumor, the mechanisms that explain the gradual slackening of the rate of tumor growth are different from those that obtain when it is grafted in the form of a solid tumor; this shows that these mechanisms depend on extrinsic factors relating to the metabolic conditions, the cellular microenvironment, and intercellular contact phenomena. The phenomena that occur in an irradiated tumor are quantitatively similar to those found in normal tissue, but they may differ from the qualitative point of view and with respect to temporal behavior. These differences, that doubtless depend on the type of tumor, will have to be analyzed before radiotherapy can be used to the maximum advantage. (auth)

12259 COMPUTER STUDIES ON THE MECHANISMS CONTROLLING CELLULAR PROLIFERATION. Tsanev, R.; Sendov, B. (Bulgarian Academy of Sciences, Sofia). pp 453-61 of Effects of Radiation on Cellular Proliferation and Differentiation. Vienna; International Atomic Energy Agency (1968).

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco. See STI/PUB-186; CONF-680413.

A model of the autoregulation of mitotic and functional activity of the cells was used to study by means of a digital computer, the reaction of different cellular systems (a synchronous cellular population, liver, and epidermis) to injuring agents disturbing the steady state of the system. The reaction of the cellular models to different kinds of injury was found to imitate adequately some particular features of the real regenerative processes. The model may also be useful to check different hypotheses concerning the mechanisms by which irradiation affects cellular proliferation. (auth)

12260 EFFECTS OF X-IRRADIATION ON CELL PROLIFERATION IN NORMAL EPITHELIUM AND IN TUMOURS OF THE HAMSTER CHEEK POUCH. Brown, J. M.; Berry, R. J. (Churchill Hospital, Oxford, Eng.). pp 475-91 of Effects of Radiation on Cellular Proliferation and Differentiation. Vienna; International Atomic Energy Agency (1968).

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco. See STI/PUB-186; CONF-680413.

The stratified squamous epithelium of the hamster cheek pouch is a steady-state renewal system that is particularly suitable for kinetic analysis, owing to the absence of hair follicles and sweat glands that complicate the study of skin. Tumors were induced in the cheek pouches of inbred Syrian-derived hamsters with 9, 10 dimethyl-1, 2 benzanthracene (DMBA). These morphologically typical, exophitic squamous carcinomas display varying degrees of differentiation. The kinetics of proliferation in both tumors and normal tissue were studied autoradiographically after administration of ^{3}H-thymidine in single pulses and by continuous labeling techniques, before and after local irradiation of the cheek pouches with single doses of 500 and 1000 rad of 250 kVp x rays. For the unirradiated hamster, the cell cycle in the normal epithelium of the cheek pouch was 12 to 13 times longer than in the tumors induced in the pouch. The fraction of proliferating cells (growth fraction) was 100% in the normal epithelium, and was considerably smaller, although variable, among the carcinogen-induced tumors. There was a diurnal rhythm in the progression of cheek pouch cells through the division cycle that was not seen in the tumors induced in the pouch. After a dose-dependent delay in their first post-irradiation division, cells of the cheek pouch epithelium showed a small (about 20%) reduction in their cell cycle; in contrast, the tumor cell cycle was marginally elongated. These results are discussed in the context of changes that might occur in the proliferation kinetics of human tumors and normal tissues included in the field of irradiation during a fractionated course of radiotherapy. (auth)

12261 OXYGENATION AND CELL KINETICS AFTER IRRADIATION IN A TRANSPLANTABLE OSTEOSARCOMA. Van Putten, L. M. (National Defense Research Organization, TNO, Rijswijk, Netherlands). pp 493-505 of Effects of Radiation on Cellular Proliferation and Differentiation. Vienna; International Atomic Energy Agency (1968).

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco. See STI/PUB-186; CONF-680413.

In a transplantable osteosarcoma studies were made of the surviving cells after an x-ray dose of 1000 rad. By means of cell labeling in vivo with ^{125}IUDR, it was possible to estimate the total cell number per tumor at different intervals after irradiation, and by inoculation of the suspended tumor cells into isogeneic recipients, a quantitative assay of cell survival could be performed. Similarly, the oxygenation of the survivors could be assayed by studying the radiosensitivity of the surviving cells in vivo. Before irradiation, 14% of the tumor cells were anoxic. After irradiation, more than 90% of the cells were anoxic for two days, but then the percentage of anoxic cells decreased rapidly to the preirradiation value or below. Over a period of five days after irradiation, there was an apparent progressive loss from the tumor of competent surviving cells as estimated by the transplantation assay. Since a similar loss could not be observed after chemotherapy in vivo with cyclophosphamide to a similar cell survival level, it seems extremely unlikely that this cell loss was an artifact induced by trypsinization of damaged cells. It is also not a phenomenon typical of radiation, since it was not observed in irradiated bone marrow assayed for surviving colony-forming units by the spleen colony technique. To explain the phenomenon, a tumor model was proposed in which there was continuous loss of cells caused by vascular insufficiency. As the tumor cells proliferated in the well-vascularized areas, other cells were pushed to the periphery where they became anoxic and subsequently died. If the cells were brought into suspension immediately after irradiation, most of the survivors were among these anoxic cells. A delay of a few days permitted further growth of the tumor; its volume and total cell number increased

for 2 to 4 days. This was probably due to the last cell divisions of doomed well-oxygenated cells, and it seems reasonable to assume that this caused the death of the peripheral, previously anoxic cells, since they formed the cell compartment that at the time of irradiation already had a somewhat impaired vascular supply. Simultaneously the few perivascularly located surviving cells proliferated, and thus the well-oxygenated cells increased in number while the initially more numerous anoxic survivors died. The implications of this model for radiotherapy are discussed. (auth)

12262 RECOVERY OF REPRODUCTIVE ACTIVITY AND THE MAINTENANCE OF STRUCTURAL INTEGRITY IN THE INTESTINAL EPITHELIUM OF THE MOUSE AFTER SINGLE-DOSE WHOLE-BODY ^{60}Co GAMMA-RAY EXPOSURES. Lesher, S.; Bauman, Janie (Argonne National Lab., Ill.). pp 507-13 of Effects of Radiation on Cellular Proliferation and Differentiation. Vienna; International Atomic Energy Agency (1968).

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco. See STI/PUB-186; CONF-680413.

The survival of animals exposed to ionizing radiation is dependent on the maintenance of certain critical cell renewal systems, e.g., the intestinal epithelium and bone marrow. Since radiation interferes with cell production, these tissues cannot be maintained unless there is an early resumption of reproductive activity and the necessary metabolic processes that precede cell division such as DNA synthesis. Cell death increases with increasing dose, hence the replacement of the proliferative populations and the continued flow of cells into the maturation and functional compartments is not possible without an accelerated production rate. Previously reported experiments show that after single whole-body exposure damage, repair, and recovery of the rapidly dividing crypt cells of the intestinal epithelium follow a well-defined pattern. Immediately after or during irradiation (as a result of radiation damage), cells in G_2 and those that move into G_2 from S are retarded or blocked there, the number of cells in S synthesizing DNA and their synthesis rate are reduced, and the movement of cells from G_1 into S is slowed or stopped. At high dose levels, many cells are severely damaged and die, reducing the crypt cell populations to a point below the critical level. During recovery, the surviving cells resume mitosis and with each cycle severely damaged cells are eliminated. As a result, the crypt is repopulated with highly viable cells. The new proliferative population is not triggered into differentiation as the cells move into the upper crypt maturation compartment; therefore, within a few divisions the proliferative compartment expands rapidly. At the same time the generation cycle is accelerated. The extent of damage and the degree of compensatory reaction increases with dose. In this paper, the magnitude of the unrepaired damage and the extent of the compensatory changes during the recovery period at seven single dose exposure levels (75, 150, 300, 500, 600, 750, and 1000 R) are presented and their significance is discussed. (auth)

12263 EVIDENCE FOR THE CELLULAR BASIS OF INTESTINAL DEATH IN MICE, FROM AN ANALYSIS OF DOSE-EFFECT RELATIONSHIPS MODIFIED BY QUALITY OF RADIATION, DOSE RATE, FRACTIONATION AND ANOXIA. Alper, Tikvah (Hammersmith Hospital, London); Hornsey, Shirley; Pike, M. C.; Smith, P. pp 515-30 of Effects of Radiation on Cellular Proliferation and Differentiation. Vienna; International Atomic Energy Agency (1968).

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco. See STI/PUB-186; CONF-680413.

When animals are killed by radiation, as by other toxic agents, the dose-effect relation may be characterized by the LD_{50} together with the spread or variance of the observations. It is generally accepted that the type of dose-effect curve (a probability curve) obtained in such experiments is to be ascribed to subtle and uncontrollable biological variations within any group of experimental animals. Conditions of irradiation were used such that the values of LD_{50} might be widely different, e.g., for intestinal death (at 4 to 5 days) the LD_{50} for animals exposed to fast electrons while breathing oxygen was 1020 rad, while for animals breathing nitrogen it was 2800 rad. In that example, the variances of the two sets of data were in exactly the same ratio as the LD_{50} values, so that the anoxia operated as a dose-modifying agent. For other methods of modifying the LD_{50}, however, this was not true; for example when the LD_{50} was increased from 1200 to 1600 rad by fractionation the variance remained constant. A computer programme was set up to perform probit analyses on animal survival curves, and to test whether dose modification or parallel slopes (i.e., variances proportional to LD_{50} values, or constant variances) provides the better model for the comparison of the results of irradiation in any two sets of conditions. It was found, in general, that conditions that give true dose modification of cell survival curves (e.g., anoxia) are also dose-modifying for the animal survival curves, whereas conditions that act as if to change the shoulder of a cell survival curve, but not its slope (e.g., dose fractionation) act similarly with respect to animal survival curves. Thus the biological variability that expresses itself in the probability curve for animal survival seems to be closely linked with the survival curve for the particular cell population the depletion of which leads to the gastro-intestinal syndrome. (auth)

12264 QUANTITATIVE CELLULAR ASPECTS OF THE EPITHELIUM IN THE SMALL INTESTINE OF MICE FOLLOWING TOTAL-BODY IRRADIATION: CELL DEATH, MITOSIS, AND CHROMOSOME ABERRATIONS. Devik, F. (State Inst. of Radiation Hygiene, Oslo. Univ. of Oslo). pp 531-9 of Effects of Radiation on Cellular Proliferation and Differentiation. Vienna; International Atomic Energy Agency (1968).

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco. See STI/PUB-186; CONF-680413.

Experiments were undertaken to study cell death, mitosis, and chromosome aberrations in the intestinal epithelium after whole-body irradiation. Mice were irradiated with x-ray doses of 200 rad, 350 rad, and 700 rad, and histological slides and cytological squash preparations were made from material obtained from autopsies 30 minutes, 1, 2, 3, 4, 6, 9, 12, and 24 hr, and 2, 3, 4, 5, 7, and 9 days after irradiation; 282 mice were used in all. Counts of pyknotic cells and of mitoses were made only in crypts sectioned longitudinally, and expressed as numbers per section of one crypt. Abnormal mitoses were determined by scoring anaphases, and expressed as percentage of the total number of mitoses. Early cell death, during the first hours and days after irradiation, was confined to the site of the regenerative compartments in the crypts. Labeling with ^{3}H-thymidine and the analysis of autoradiographs showed that the pyknotic cells were labeled to the same extent as the mitoses, and therefore mainly belonged to the actively dividing compartment of cells. A number of cells died during the initial depression of mitosis, when hardly any cell division took place. Quite a number of the mitoses showed chromosome aberrations the first day after resumption of the mitotic activity. It can be assumed that such abnormal mitoses account for a considerable number of the cells that die, but apparently not for the greater part, as has frequently been assumed. Evidence obtained showed that there are good reasons to consider that, when mitotic activity is resumed after irradiation, many of the cells that have prepared for division die instead of entering mitosis. From these studies, three different forms of early cell death after irradiation can be distinguished; apart from cells that die as a consequence of abnormal mitosis, there is one wave of pyknotic cells that die during the mitotic depression, and one wave of cells that become pyknotic at the time when mitosis is resumed. (auth)

12265 EFFECTS OF SMALL RADON DOSES ON THE YOSHIDA SARCOMA IN RATS. Henn, Otto; Karrer, Karl (Forschungsinstitut Gastein, Badgastein, Austria. Univ., Vienna). Strahlentherapie; 138: 481-8(Oct 1969). (In German).

After intravenous implantation of a Yoshida sarcoma in rats, the influence on these tumors of breathing radon-containing air from the cure-galeries from Badgastein-Böckstein was studied. The net tumor inhibiting effect of a 4 day treatment with Mitomen (2.5 mg/kg) was reduced by the inhalation of the radioactive air (3.5 nCi/l of air, 22°C, humidity of 90 to 100%). The inhalation of radon-air has no influence on the tumor growth in the animals not treated by the drug. The necessity of more complete and detailed studies is stressed. (auth)

12266 THE EFFECT OF RADIOTHYROIDECTOMY ON BLOOD VOLUME, RED CELL SURVIVAL , AND IRON KINETICS IN PUPPIES. Bozzini, C. E.; Barrio Renso, M. E.; Kofoed, J. A. (Univ. Nacional, Buenos Aires. Comision Nacional de Energia Atomica, Buenos Aires). Experientia; 25: 861-2(15 Aug 1969).

Six 3-week-old dogs of the same littermate were used for the experiment. Three were injected with ^{131}I while the remaining three served as controls. One year later determinations were made of hemoglobin content, blood volume, red cell survival, and iron turnover rates. Chromium-51 was used in determinations of red cell volume and survival. Results are tabulated. The hemoglobin content and hematocrit values showed a decrease of about 32% in the thyroidectomized animals and the plasma volume increased by 33%. Anemia in the thyroidectomized dog appeared to result from a diminished rate of red cell production rather than from an accelerated rate of red cell destruction. (H.L.W.)

12267 ROL' NADPOCHECHNIKOV V BIOKHIMICHESKIKH SDVIGAKH PRI DEISTVII MALYKH DOZ IONIZIRUYUSHCHEI

RADIATSII. (Role of Adrenal Glands in Biochemical Shifts During the Exposure to Small Doses of Ionized Radiation). Cherkasovoi, L. S. (ed.). Minsk; Izdatel'stvo Nauka i Tekhnika (1969). 188p.

Current problems of radiobiology and the importance of the neuro-endocrine system in the development of radio-biochemical effects are examined in the first chapter. The second chapter includes experimental data obtained on the role of hypothalamo-hypophyseal adrenaline system in the development of radio-biochemical shifts and changes in white rats exposed to x or neutron irradiation with 40 and 135 rad. Results of studies of protein fractions (DNP, RNP, and groups of acid proteins) in the cerebral hemisphere, cerebellum, spinal cord, and liver in irradiated animals and in adrenalectomized and irradiated animals are discussed in the third chapter. The changes of alanine-aspartataminotransferase in the subcellular fractions of the cerebral hemisphere and cardiac muscle are analyzed in the fourth chapter. Data obtained are summarized in the last chapter and conclusions are given on the role played by the adrenal cortex hormones in the appearance and development of radioinduced changes. (713 References) (R.V.J.)

12268 ON THE VARYING SENSITIVITY TO THE X-RAY ACTION OF MICE MAMMARY GLANDS OF THE HIGHLY CANCEROUS STRAIN C_3H. Gersamiya, G. K. (Tbilissi Inst. of Oncology, USSR). Soobshch. Akad. Nauk Gruz. SSR; 56: 477-80(Nov 1969). (In Russian).

A study of the effect of ionizing radiation on the mammary gland tissue of mice of the C_3H strain during the process of carcinogenesis found that the dose of 2,000 roentgen did not serve as threshold stimulation for the epithelial cells of the mammary glands that are in the process of development but which have not yet undergone final differentiation. The dose of 2,000 R is the threshold stimulation for the epithelial cells of the mammary glands, characterized by hyperplastic growth with formation of foci of proliferation and microcancers. Under the action of the above Roentgen dose the anaplased tumor cells underwent dystrophic changes accompanied by a decrease of the number of nuclear and cytoplasmatic nucleoproteids in them. (auth)

12269 RADIATION AND CANINE AVOIDANCE LEARNING. Ellis, Richard Harvey. Fort Collins, Colo.; Colorado State Univ. (1969). 152p.

Thesis.

The effect of three dose levels of radiation exposure on escape, avoidance and extinction learning by the beagle was investigated. The distinctiveness of each learning task was established independently of radiation exposure. Incidental measures of responsiveness to the experimental situation were also taken. Ten young beagles were assigned to each of three groups: untreated control, 140R gamma-ray, whole-body administered at two days of age, and 325R—same as above. Habituation was followed by escape training in which the dog learned a leg flexion to terminate shock to a criterion of 13 out of 15 successful responses. Avoidance training to the same criterion ensued and was followed by extinction for ten daily sessions of fifteen trials each. Escape was learned quickly, uniformly and efficiently; avoidance was only learned by two-thirds of each group and learning measures were variable. A period of consolidation was evident after the first avoidance response and avoidance responding increased more slowly and reached a maximum later than escape. Dose-related increases in avoidance learning measures fell just short of significance. Both irradiated groups had higher avoidance frequencies in the second half of consolidation and in the final precriterion session than controls. The regression of response latency on extinction sessions was only significant for controls. Frequency of defecation for the 325R group was double that of the others. Intertrial interval (ITI) responding was subject specific, highly variable and was highest in escape, lowest in extinction. ITI responding was a constant for longer intervals and a direct function of length of prior interval for shorter ones. ITI responding in extinction was higher for controls than for irradiateds for whom it declined markedly at longer interval lengths. Avoidance learning theories and parametric studies are reviewed and recommendations for future studies of aversive behavior and the effects of radiation exposure are extended. (Diss. Abstr.)

12270 CHANGES IN RAT TESTES UNDER THE INFLUENCE OF SOFT X-RAYS. Bondareva, E. N. (Scientific Research Inst. of Radiation Hygiene, Leningrad). Radiobiologiya; 9: 697-700(1969). (In Russian).

A comparative study was made of the effects of soft (13 keV, 2000 R) and hard (73 keV, 500 R) x ray single whole-body irradiation on the testes of white rats in a long-term experiment (1 to 190 days). It was established that both types of irradiation led to monotypic changes in the weight of the testes and enzyme activity; however, hard radiation produced a decrease in the indexes studied at later periods. (tr-auth)

12271 QUANTITATIVE EVALUATION OF THE INFLUENCE OF RADIATION ON THE HOMOTRANSPLANTATION ACTIVITY OF LYMPHOID CELLS. Seslavina, L. S. (Inst. of Biophysics, Moscow). Radiobiologiya; 9: 715-19(1969). (In Russian).

When a mixture of spleen cells from CBA and C57BL mice is transplanted into lethally irradiated recipient mice, an inactivation of the stem cells is observed. The inactivation of the stem cells was investigated using cells from irradiated donor CBA mice at various periods after irradiation at a dose of $LD_{50/30}$ as one of the components of the mixture. After 1 hr, 1, 7, and 14 days after irradiation, the ability to inactivate nonsyngenic stem cells was practically not manifested. The ability for inactivation was partially restored 30 days after irradiation, and only on the 60th day did the inactivation of the stem cells in the mixture proceed normally. The irradiation of cells of the spleen and lymph nodes of CBA mice in vitro at a dose of 10,000 R changes the phenomenon of inactivation of nonsyngenic stem cells. (tr-auth)

12272 EFFECTS OF IONIZING RADIATIONS ON CELLS OF VARIOUS COMPONENTS OF THE DEVELOPING RAT CEREBELLAR CORTEX. Korogodina, Yu. V.; Glotov, N. V.; Dubrovina, V. M. (Inst. of Medical Radiology, Obninsk, USSR). Radiobiologiya; 9: 742-7(1969). (In Russian).

The work was devoted to a comparison of the radiosensitivity (evaluated according to the lethal effects of radiations on cells) of various components of the developing cortex of the rat cerebellum, the outer granular, ganglionic, and inner granular layers. It was shown that the bulk of the cells of the inner granular layer is approximately 20 times as stable as the cells of the outer granular layer; in the Purkinje's cells, pycnosis of the nuclei was not observed. It was also shown that the rate of development of pycnotic degeneration of the nuclei is determined not so much by the dose of irradiation as by the individual peculiarities of the animals. (tr-auth)

12273 INVESTIGATION OF THE ROLE OF BIOGENIC STIMULATORS IN THE REGULATION OF THROMBOCYTOPOIESIS OF IRRADIATED ANIMALS. Traskunova, I. V. (Central Roentgenoradiological Scientific Research Inst., Leningrad). Radiobiologiya; 9: 757-60(1969). (In Russian).

In the experiment we investigated the thrombocytopoietic properties of the blood plasma of irradiated animals during acute radiation sickness. It was shown that the blood plasma of irradiated rabbits possesses thrombocytopoietic activity only in the first week of radiation sickness. It was hypothesized that during this period biogenic stimulators are formed. (tr-auth)

12274 COMPARATIVE CELLULAR AND SPECIES RADIOSENSITIVITY. Proceedings of the International Seminar, Kyoto, May 20-23, 1968. Bond, Victor P.; Sugahara, Tsutomu (eds.). Tokyo; Igaku Shoin Ltd. (1969). 325p. $17.00. (CONF-680518).

Separate abstracts were prepared for all 23 of the papers presented. Topics included physiological and genetic differences in radiosensitivity, bone marrow and gastrointestinal death, and species differences in recovery patterns. (F.M.M.)

For abstracts of individual papers see: 12115, 12223, and 12275-12295.

12275 RADIATION MORTALITY IN DIFFERENT MAMMALIAN SPECIES. Bond, Victor P. (Brookhaven National Lab., Upton, N. Y.). pp 5-19 of Comparative Cellular and Species Radiosensitivity. /Bond, Victor P.; Sugahara, Tsutomu (eds.). Tokyo; Igaku Shoin Ltd. (1969).

From Conference on Comparative Cellular and Species Radiosensitivity in Animals, Kyoto, Japan. See CONF-680518.

LD_{50} values for deaths from the bone marrow syndrome, expressed in terms of absorbed dose in tissue, were given for a number of mammalian species. The cardinal factors leading to serious illness and death, marrow depletion of neutrophils, platelets, and red cells in the blood, are discussed. (F.M.M.)

12276 DIFFERENCES IN HEMATOPOIETIC DEATH AMONG INBRED STRAINS OF MICE. Kondo, Kyoji; Nagami, Toshiyuki; Teramoto, Shoji (Nagoya Univ., Japan). pp 20-29 of Comparative Cellular and Species Radiosensitivity. /Bond, Victor P.; Sugahara, Tsutomu (eds.). Tokyo; Igaku Shoin Ltd. (1969).

From Conference on Comparative Cellular and Species Radiosensitivity in Animals, Kyoto, Japan. See CONF-680518.

Inbred strains of mice were produced, and tested for the biological response to ionizing radiation, by percentage dead vs dose in male mice at the age of 3 to 4 months. In the ten inbred strains tested, the most susceptible strain was NC ($LD_{50/30}$: 547R) and the most resistant one was I-tester ($LD_{50/30}$: 790R). (TSS) (auth)

12277 VARIATION IN RADIOSENSITIVITY OF MICE IN RELATION TO THEIR PHYSIOLOGICAL CONDITIONS. Sugahara, Tsutomu; Tanaka, Tomizo; Nagata, Hiroji; Man-i, Masano; Ki-

kuchi, Kunio (Kyoto Univ.). pp 30-41 of Comparative Cellular and Species Radiosensitivity. /Bond, Victor P.; Sugahara, Tsutomu (eds.). Tokyo; Igaku Shoin Ltd. (1969).

From Conference on Comparative Cellular and Species Radiosensitivity in Animals, Kyoto, Japan. See CONF-680518.

Variations in the sensitivity of adult dd/YF male mice to whole-body irradiations were studied after various physiological stimuli; fasting for 48 hr, heavy bleeding, low barometric treatment, and long-term running on a treadmill. These experiments showed that mice appear to be radioresistant when their hemopoietic activity is high. The relation between hemopoietic activity and radiosensitivity was also analyzed in mice subjected to heavy bleeding. The hemopoietic recovery process was a significant factor in increasing survival. Strain differences were noted in the effect of heavy bleeding on hemopoietic recovery. A new radioprotective agent, adrenochrome mono-guanylhydrazone methanesulfonate, was effective in very low doses. It is suggested that some unknown physiological alterations in cells or tissues may modify the radiosensitivity of animals. The implication of these experiments in the comparative sensitivity of mammals is discussed. (auth)

12278 PATTERNS OF RECOVERY FROM LARGE SINGLE-DOSE EXPOSURE TO RADIATION. Casarett, George W. (Univ. of Rochester School of Medicine and Dentistry, N. Y.). pp 42-52 of Comparative Cellular and Species Radiosensitivity. /Bond, Victor P.; Sugahara, Tsutomu (eds.). Tokyo; Igaku Shoin Ltd. (1969). (UR-49-934).

From Conference on Comparative Cellular and Species Radiosensitivity in Animals, Kyoto, Japan. See CONF-680518.

Quantitative data for mammalian species on patterns of sensitivity or resistance to radiation lethality after previous single radiation exposure are reviewed, compared, and discussed with respect to their meaning in terms of injury, repair, and recovery. Recovery rates, and the details of the patterns or time-courses of recovery, vary with species, strain, sex, size of conditioning dose, its rate, criterion level of mortality, parts of body exposed, experimental methods, and perhaps other factors. Although a simple exponential recovery function may be a reasonable fit grossly to some recovery data during certain parts of the recovery pattern, the fine structure of the recovery curves show significant deviations from this simple function, including cyclic phenomena, evidences of reversals of recovery trends, and even increased resistance or over-recovery, and recovery rates and patterns cannot be described generally and adequately by single rate constants. Available data indicate no clearcut relation between recovery rate and body size, basal metabolic rate, radiation LD_{50}, or natural life span among species. Hypotheses relating responses of cells, tissues, and systems to rates and patterns of recovery and residual injury are discussed briefly. (auth)

12279 THE DIFFERENCE IN ERYTHROPOIETIC RECOVERY AFTER IRRADIATION IN TWO STRAINS OF MICE. Tsuchiya, Takehiko; Hayakawa, Jun-ichiro; Tamanoi, Itsuro; Muramatsu, Susumu; Dei, Toshio (National Inst. of Radiological Sciences, Chiba, Japan). pp 53-62 of Comparative Cellular and Species Radiosensitivity. /Bond, Victor P.; Sugahara, Tsutomu (eds.). Tokyo; Igaku Shoin Ltd. (1969).

From Conference on Comparative Cellular and Species Radiosensitivity in Animals, Kyoto, Japan. See CONF-680518.

The injury to and recovery in the hematopoietic tissues of both C57BL and CF #1 mice with different $LD_{50/30}$ were studied at whole-organism level by the methods of ^{59}Fe uptake, nucleated cell count, and differential cell count, and at cellular level by exo- and auto-repopulating method. The recovery pattern following exposure was different in the spleen but similar in the bone marrow for both strains by ^{59}Fe uptake, the number of nucleated cells and the quantitative histological analysis, and the total erythropoiesis was contributed to more by the bone marrow than by the spleen. The injury and repopulating capacity of the nucleated cells after irradiation were similar for both strains by an exo-repopulating method. In the study by auto-repopulating method, the degree of initial injury to bone marrow in the temporarily shielded tibia depended on the radiation dose and the proliferation rate from the shielded tibia was similar for both strains. The repopulation capacity, however, was greater in C57BL than in CF #1. The difference in the radiosensitivity in C57BL and CF #1 mice measured by $LD_{50/30}$ seemed to be due to the fact that the number of nucleated cells including stem cells in bone marrow is much higher in the normal state in C57BL than in CF #1. (auth)

12280 X-RAY SURVIVAL OF MAMMALIAN CELLS IN CULTURE. Sinclair, Warren K. (Argonne National Lab., Ill.). pp 65-78 of Comparative Cellular and Species Radiosensitivity. /Bond, Victor P.; Sugahara, Tsutomu (eds.). Tokyo; Igaku Shoin Ltd. (1969).

From Conference on Comparative Cellular and Species Radiosensitivity in Animals, Kyoto, Japan. See CONF-680518.

The factors influencing survival after x irradiation of cultured mammalian cells include physical factors (Linear Energy Transfer (LET), dose-rate, fractionation) state of the cell (ploidy, stage of cell cycle), conditions of irradiation (temperature, presence of oxygen), and the presence or absence of inhibiting, sensitizing, or protective agents. Still unknown is the interrelation between many of these factors; whether, for example, effects can be additive, synergistic, or cancel one another. The age response in the cell generation cycle and its relation to other factors is discussed. Inhibition of DNA synthesis affects the response of G_1 Chinese hamster cells but variations in response with cell age still occur. This demonstrates that the age response variation is not due to DNA synthesis solely. Additional studies indicate that part of the observed variations do not depend on RNA or protein synthesis either and that some other process is involved. Arresting DNA synthesis pre- and post-irradiation during S has essentially no effect on survival. It was established also in Chinese hamster cells that the oxygen effect is the same at all stages of the cell cycle (i.e., the Oxygen Enhancement Ratio (OER) does not vary) whereas the protective effect of cysteamine has a marked differential effect throughout the cycle. These interactions show that while the protective action of cysteamine cannot be related solely, if at all, to anoxia, its protective action may depend on factors also involved in controlling the cell cycle age response. (TSS) (auth)

12281 A CYTOKINETIC COMPARISON OF HEMATOLOGICAL CONSEQUENCES OF RADIATION EXPOSURE IN DIFFERENT MAMMALIAN SPECIES. Fliedner, Teodor M. (Univ. of Ulm, Ger.). pp 89-101 of Comparative Cellular and Species Radiosensitivity. /Bond, Victor P.; Sugahara, Tsutomu (eds.). Tokyo; Igaku Shoin Ltd. (1969).

From Conference on Comparative Cellular and Species Radiosensitivity in Animals, Kyoto, Japan. See CONF-680518.

The hematological changes seen in man after a sufficient dose of ionizing whole-body irradiation indicate a close correlation between granulocytopenia and infection as well as thrombocytopenia and bleeding. In all mammalian species examined, a similar correlation was seen. However, the absolute dose necessary to produce a similar degree of granulocytopenia and thrombocytopenia differs widely. Furthermore, the time course for the development of granulocytopenia, thrombopenia, and anemia differs between species and man but also between animal species. Thus, while a critical phase of infection and bleeding is seen in man 4 to 5 weeks after irradiation in the mid-lethal-dose range, an equivalent phase in all laboratory animals studied is seen during the second and third week after irradiation. The initial hematological changes per se are a function of the renewal characteristics of the relevant cell renewal system. Whether or not bleeding and infection manifest themselves depends in part on external factors. However, the pattern of bone marrow cell regeneration is still far from being understood in detail since the structure and functional activity of stem-cell pools in most species have not been analyzed satisfactorily. (auth)

12282 CELLULAR KINETICS IN THE MOUSE HEMOPOIETIC SYSTEM AFTER EXPOSURE TO IONIZING RADIATION. Ueno, Yori (Kyoto Univ.). pp 102-11 of Comparative Cellular and Species Radiosensitivity. /Bond, Victor P.; Sugahara, Tsutomu (eds.). Tokyo; Igaku Shoin Ltd. (1969).

From Conference on Comparative Cellular and Species Radiosensitivity in Animals, Kyoto, Japan. See CONF-680518.

The process of recovery from cell damage induced by ionizing radiation was analyzed in vivo, with the use of endogenous spleen colony counts in mice x-irradiated by a split-dose exposure technique. The time course of endogenous spleen colony counts after whole-body irradiation with 400 R + 400 R to 90-day-old dd/YF female mice, was divided into three stages. In the first stage, the endogenous spleen colony (ESC) count increased rapidly for 4 hr after exposure; in the second stage (4 to 14 hr), the ESC count first fell, reaching minimum at 9 hr and then increased again. In the third stage, a similar pattern was observed, and thereafter, the ESC count increased. The first stage was the period of repair, as described by Elkind. This stage coincides with the period of seeding of ESC-forming cells from the active bone marrow of the spleen. The second stage appears to correspond to one generation cycle of ESC-forming cells. The ESC count at 9 hr is almost the same as that at 19 hr. That is, the number of ESC-forming cells in the second stage is almost the same as that in the early third stage. It means that half of the produced daughter cells leaves the ESC-forming cell compartment after mitosis at the second stage, along the process of differentiation. The change in the early third stage presented here was not observed in the part of the graph published by Till and McCulloch that seemed to correspond to the early third stage. There is a diurnal variation with a cycle time of 8 hr in the D_0 value of the ESC count. The change shown in the early third stage appears to be based on the diurnal variation. (auth)

12283 SPECIES DIFFERENCES IN LEUKOCYTE RESTORATION AFTER IRRADIATION. Patt, Harvey M. (Univ. of California Medical Center, San Francisco). pp 112-22 of Comparative Cellular and Species Radiosensitivity. /Bond, Victor P.; Sugahara, Tsutomu (eds.). Tokyo; Igaku Shoin Ltd. (1969).

From Conference on Comparative Cellular and Species Radiosensitivity in Animals, Kyoto, Japan. See CONF-680518.

Evolution of the leukocyte response to radiation is dependent upon species and strain as well as dose and dose rate. A species dependency applies particularly to the granulocytes, less so to the lymphocytes. Several factors enter into an analysis of the differential response to radiation within and among species. These pertain to cell radiosensitivity, cell population kinetics, and organizational and regulatory features of the system. Although facets of the overall leukocyte response can be understood in terms of these variables, it is not yet possible to make quantitative predictions about the entire spectrum of leukocyte behavior in different species under different conditions of irradiation. This follows from a still rather superficial understanding of normal leukocyte systems and their control. The factors entering into mechanisms of blood depopulation and repopulation cannot be deduced from study of the time course alone. The known complexities provide enough flexibility such that any number of variables at the level of the cell and/or the system could account for strain and species differences. (auth)

12284 KINETICS OF CELL TURN-OVER IN IRRADIATED MAMMALIAN THYMUS WITH SPECIAL REFERENCE TO DNA SYNTHESIS. Yamaguchi, Takeo (National Inst. of Radiological Sciences, Chiba, Japan). pp 140-54 of Comparative Cellular and Species Radiosensitivity. /Bond, Victor P.; Sugahara, Tsutomu (eds.). Tokyo; Igaku Shoin Ltd. (1969).

From Conference on Comparative Cellular and Species Radiosensitivity in Animals, Kyoto, Japan. See CONF-680518.

All the types of lymphocytes in rat thymus depopulated severely after sublethal x irradiation (360 R), whereas the net number of reticular cells did not decrease but rather increased temporarily. Older non-mitosable small-sized lymphocytes were more resistant to early radiation killing than the younger ones, but they disappeared gradually from the tissue, presumably partly through dying from cellular ageing and partly through migrating from cortex via medulla to the circulation. DNA synthesis was entirely suppressed in all the thymic cells during a few hours after irradiation. By the 5th hr, only reticular cells resumed DNA synthesis. The repopulation of lymphocytes took place later than 1 day after irradiation. The larger the cell size, the faster was the beginning of the repopulation. During the repopulation period, large- and medium-sized lymphocytes as well as reticular cells synthesized DNA actively. The regenerating cells reutilized the breakdown of DNA of dead lymphocytes. The small-sized lymphocytes including the reutilized DNA migrated actively from the regenerating thymus to other lymphoid tissues. The cellular mechanism involved in the regeneration of thymus from the radioinduced involution was discussed. (auth)

12285 BONE MARROW TRANSPLANTATION AND PARTIAL BODY SHIELDING FOR ESTIMATING CELL SURVIVAL AND REPOPULATION. van Bekkum, Dirk W. (Radiobiological Inst., TNO, Rijswijk, Netherlands). pp 175-92 of Comparative Cellular and Species Radiosensitivity. /Bond, Victor P.; Sugahara, Tsutomu (eds.). Tokyo; Igaku Shoin Ltd. (1969).

From Conference on Comparative Cellular and Species Radiosensitivity in Animals, Kyoto, Japan. See CONF-680518.

A comparison between the repopulating efficacy of injected bone marrow and shielded bone marrow in situ was attempted in the mouse, employing the spleen weight on the 10th day after irradiation instead of the spleen colony count. Very small numbers of surviving cells in situ were obtained by irradiating shielded legs with graded doses of x rays. The results, although not enabling a definite conclusion, indicate that the repopulation capacity of shielded cells lies between 10 and 100% of that of injected bone marrow cells. The regeneration of the lymphatic tissues after whole-body irradiation in mice is highly dependent on the activity of the thymus. Evidence is presented that supralethal doses of x radiation result in a deficient recovery of the thymus epithelium. The occurrence of isologous secondary disease is attributed to a thymic disfunction that results in an auto-immune reaction. Support for this hypothesis was obtained by the demonstration that renal implants of newborn thymus can largely prevent the disease and by an initial curative effect of treatment with cyclophosphamide. (auth)

12286 HEMATOPOIETIC DEATH AND ITS PREVENTION BY BONE MARROW TRANSPLANTATION IN IRRADIATED MICE. Wakisaka, Gyoichi; Yamagishi, Morihisa; Hama, Masaharu; Adachi, Kazushige; Tazawa, Hiroshi (Kyoto Univ.). pp 193-201 of Comparative Cellular and Species Radiosensitivity. /Bond, Victor P.; Sugahara, Tsutomu (eds.). Tokyo; Igaku Shoin Ltd. (1969).

From Conference on Comparative Cellular and Species Radiosensitivity in Animals, Kyoto, Japan. See CONF-680518.

Several experiments to reduce the incidence of secondary disease in mice are described. The bone marrow donor is irradiated with or without AET pretreatment to reduce the number of immunologically competent cells. Methotrexate is administered at various days after lethal irradiation and allogenic-bone-marrow transplantation. Allogenic fetal liver is used as a donor hemopoietic tissue. The effect of preservation of bone marrow on secondary disease is studied. Thymectomized mice are lethally irradiated, transplanted with syngenic bone marrow and, 4 weeks later, are used as allogenic donors. The effect of the treatment on the incidence of secondary disease is studied. In some experiments, thymectomized mice are used as recipients. All of the treatments have effects to some extent on the incidence of secondary disease, but the effects are still not satisfactory. It is pointed out that bone-marrow transplantation prevents only bone marrow death and does not prevent radiation injury of other organs. (auth)

12287 ROLE OF THROMBOCYTOPOIETIC SYSTEM IN RADIATION INDUCED HEMATOPOIETIC DEATH. Nakamura, Wataru; Kojima, Eiichi; Minamisawa, Hiromi; Kankura, Takako; Kobayashi, Sadayoshi; Eto, Hideo (National Inst. of Radiological Sciences, Chiba, Japan). pp 202-10 of Comparative Cellular and Species Radiosensitivity. /Bond, Victor P.; Sugahara, Tsutomu (eds.). Tokyo; Igaku Shoin Ltd. (1969).

From Conference on Comparative Cellular and Species Radiosensitivity in Animals, Kyoto, Japan. See CONF-680518.

High incidence of extensive hemorrhage was observed in tissues and organs of mice after exposure to x-ray doses of hematopoietic death. Transfusion of isologous thrombocytes into mice after irradiation was found to prevent hemorrhage and elevate survival. Beneficial effects of thrombocyte transfusion were also confirmed by such biological indicators of radiation injury as body weight and water intake. The effectiveness was shown to be dependent, from the quantitative aspect, on the amount of thrombocytes, frequency and time of transfusions and, from the qualitative aspect, on the integrity and serotonin content of the thrombocytes. Significant therapeutic effects were obtained with more than five consecutive daily transfusions starting from the fifth day after exposure. A reduction in radiosensitivity of mice was produced by treatment of mice with anti-thrombocyte serum at a proper time prior to irradiation, but not with antierythrocyte serum. These results suggest that thrombocytopenia is the one among other depletions in formed blood elements that is responsible for hematopoietic death in mice and that the state of the precursor cells in the thrombocytopoietic system at the time of irradiation determines the fate of animals exposed to radiation doses of hematopoietic death. (auth)

12288 ANALYSIS IN TERMS OF CELLULAR PARAMETERS OF INTERANIMAL VARIATION OF HEMOPOIETIC RADIORESISTANCE. Robinson, Charles V. (Brookhaven National Lab., Upton, N. Y.). pp 211-19 of Comparative Cellular and Species Radiosensitivity. /Bond, Victor P.; Sugahara, Tsutomu (eds.). Tokyo; Igaku Shoin Ltd. (1969).

From Conference on Comparative Cellular and Species Radiosensitivity in Animals, Kyoto, Japan. See CONF-680518.

A model of acute mammalian hemopoietic radiation mortality is formulated in such a way as to relate the dose-survival curve of a population of animals with that of its stem cells. First it is assumed that an individual will survive if he has a certain threshold number of effective mature cells, given by a threshold function referred to a specified time after irradiation. A random variable, the effective proliferation factor, is then specified, that describes the proliferation initiated per stem cell. With the further assumption that stem-cell survival obeys Poisson statistics, the probability that an animal will survive any given dose is uniquely determined. This probability gives an approximately normal S-shaped dose-survival curve, the mean dose and width of which are known functions of six stem cells and five additional parameters. The width of the curve depends principally on interanimal variation of radioresistance (in turn dependent on the interanimal variations of five parameters) and randomness in the number of stem cells surviving, and in the effective proliferation per stem cell. Data on mice are analyzed in accordance with this proposed theory. (auth)

12289 HEMATOPOIETIC DEATH IN CONVENTIONAL AND GERMFREE MICE. Fliedner, Theodor M.; Heit, Hildegard (Univ. of Ulm, Ger.). pp 220-32 of Comparative Cellular and Species Radiosensitivity. /Bond, Victor P.; Sugahara, Tsutomu (eds.). Tokyo; Igaku Shoin Ltd. (1969).

From Conference on Comparative Cellular and Species Radiosensitivity in Animals, Kyoto, Japan. See CONF-680518.

Conventional and germfree mice of the ND-2 strain were given 700 R whole body x irradiation, known to cause a near 100% mortality in conventional mice within 10 to 12 days, while at least 40% of the germfree mice survive. The pattern of blood cell changes (granulocytes, platelets, erythrocytes and lymphocytes) is more or less identical in both animal groups up to the 12th day. The study on the bone marrow and spleen shows definite signs of hemopoietic recovery about 8 to 10 days after irradiation in the germfree mice while there is little if any evidence for it in conventional mice. Marrow recovery leads to a steep rise of platelets and red cells in germfree mice around day 20. Death in conventional mice is associated with thrombocytopenic bleeding and bacterial infection and the evidence indicates a possible interaction and potentiation of the bleeding tendency by bacterial toxins. Death in germfree mice—if it occurs—is associated mainly with anemia, while thrombocytopenia appears to be of lesser importance. (auth)

12290 GASTROINTESTINAL SYNDROME. Bond, Victor P. (Brookhaven National Lab., Upton, N. Y.). pp 235-43 of Comparative Cellular and Species Radiosensitivity. /Bond, Victor P.; Sugahara, Tsutomu (eds.). Tokyo; Igaku Shoin Ltd. (1969).

From Conference on Comparative Cellular and Species Radiosensitivity in Animals, Kyoto, Japan. See CONF-680518.

The relative radiosensitivity of species with respect to the gastrointestinal syndrome is presented. The variation in radiosensitivity among species is much less with the gastrointestinal syndrome than for the bone marrow syndrome, and in general the dose required to kill with the bowel is considerably higher than for the bone marrow syndrome. Evidence to date indicates that the radiosensitivity of bone marrow and bowel stem cells, as measured by the D_0 of dose-cell survival curves, is probably not markedly different. It is pointed out that while damage to the bowel undoubtedly plays a key role in the gastrointestinal syndrome, that damage to other organs plays a role as well. In particular, severe bone-marrow depression leading to neutropenia and infection is an important factor. Extensive damage to the entire bone marrow is seen only with whole-body exposure, and thus the complete gastrointestinal syndrome is not in general seen with partial body irradiation. At the high doses required to produce the gastrointestinal syndrome several independently lethal mechanisms are operative, including villus denudation, infection, blood vessel damage, fluid imbalance, and electrolyte imbalance. (TSS) (auth)

12291 DEVELOPMENT OF INTESTINAL RADIATION INJURY AND RECOVERY AT DIFFERENT TEMPERATURES IN FISH. Hyodo-Taguchi, Yasuko; Egami, Nobuo (National Inst. of Radiological Sciences, Chiba, Japan). pp 244-54 of Comparative Cellular and Species Radiosensitivity. /Bond, Victor P.; Sugahara, Tsutomu (eds.). Tokyo; Igaku Shoin Ltd. (1969).

From Conference on Comparative Cellular and Species Radiosensitivity in Animals, Kyoto, Japan. See CONF-680518.

On the basis of histopathological and autoradiographical studies of irradiated and non-irradiated goldfish and mortality rate experiments with Oryzias latipes, it was established that the intestinal epithelium is a typical cell renewal system and the intestine is a critical organ for acute radiation death of fish after whole-body irradiation with doses within the dose-independent range (3 to 32 kR). The time of death from the intestinal syndrome is about 10 days at 23°C, and both the survival time and intestinal denudation time depend on temperature. One of the causes of intestinal death in fish seems undoubtedly to be connected with a loss of sodium from the body caused by the depopulation of intestinal epithelial cells. When the total dose of irradiation was smaller than 2 kR, repopulation of cells occurred before severe damage in the intestinal epithelium. Recovery processes from intestinal injury were analyzed by radiation dose-fractionation experiments and three different phases in the recovery processes were formulated. From autoradiographic examination of the intestine of fish injected with ^{3}H-thymidine, it is likely that the recovery processes are based on the kinetics of cell populations in critical tissues. From a comparative view point, it was concluded that the nature of the radiation injury in fish is the same as that in mammals and fishes are suitable animals for studying the mechanism of radiation death in organisms. (auth)

12292 RADIATION EFFECTS AND CELL RENEWAL IN RODENT INTESTINE. Fry, R. J.; Michael; Reiskin, Allan B.; Kisieleski, Walter; Sallese, Anthony; Staffeldt, Everett (Argonne National Lab., Ill.). pp 255-70 of Comparative Cellular and Species Radiosensitivity. /Bond, Victor P.; Sugahara, Tsutomu (eds.). Tokyo; Igaku Shoin Ltd. (1969).

From Conference on Comparative Cellular and Species Radiosensitivity in Animals, Kyoto, Japan. See CONF-680518.

The correlation of survival time with cell renewal rates in different species was examined. The survival time of animals of the following species was determined after exposure to 4000 R ^{60}Co γ radiation: Mus musculus (BCF_1/Anl[Anl 66]), Praomys natalensis (multimammate mouse), Mesocricetus auratus (Syrian hamster), Cricetulus griseus (Chinese hamster), Peromyscus leucopus (white-footed deer mouse), and Chinchilla laniger (Chinchilla). The survival times ranged from about 4¾ days for BCF_1 mice and Peromyscus leucopus to almost 7 days for Mesocricetus auratus. The transit time of cells from the crypts to the tips of the villi (an estimate of cell life span) was studied in Mesocricetus auratus, Praomys natalensis, and Cricetulus griseus. The results suggest that in general the species with the longer survival times are those with longer transit times. However, the correlation is not close for the mouse, Chinese hamster, or young and adult Syrian hamster as the survival times differ by almost a factor of two, whereas the transit times differ by less than twenty percent. The methods for investigating species differences in radiosensitivity of the small intestine and the changes in cell kinetics after injury are discussed. (TSS) (auth)

12293 INJURY AND RECOVERY PATTERNS OF INTESTINAL EPITHELIUM IN IRRADIATED GERMFREE AND CONVENTIONAL ANIMALS. Matsuzawa, Taiju; Tsubouchi, Susumu (Aichi Cancer Research Inst., Nagoya, Japan). pp 271-80 of Comparative Cellular and Species Radiosensitivity. /Bond, Victor P.; Sugahara, Tsutomu (eds.). Tokyo; Igaku Shoin Ltd. (1969).

From Conference on Comparative Cellular and Species Radiosensitivity in Animals, Kyoto, Japan. See CONF-680518.

The modifying factors in the injury and recovery process of the intestinal epithelium after exposure to ionizing radiation in relation to gut death in mice, rats, and quails were studied. It was found that there is a linear relationship between the survival time for gut death and the life span of intestinal epithelial cells. The life span of intestinal epithelial cells exerts a profound influence on cell population reduction of the epithelium of sublethally irradiated animals. The recovery process from bowel damage can be divided into two phases. The proliferative phase in which the cell population increases rapidly and exponentially, and the mature phase in which over half of the cell population migrates and traverses into the villi. The growth curves of intestinal epithelial cells after exposure to various doses of ionizing radiation are straight lines on a log-normal scale. Therefore, surviving fractions can be estimated from these curves. The parameters for the radiosensitivity in epithelial cells of the small intestine of ddN-mice are as follows: $n = 4.8$ and $D_0 = 220$ rads. These cells are radioresistant. There are three main factors modifying the radiation death of animals. These are the life span, the radiosensitivity, and the number of intestinal epithelial cells. The latter two factors play an important role in the recovery process, and are essentially determined cytogenetically. Therefore they vary from species to species. (auth)

12294 RECOVERY MECHANISMS IN THE GI TRACT: SPECIES AND STRAIN DIFFERENCES. Wilson, Brother Raphael (Univ. of Notre Dame, Ind.). pp 281-7 of Comparative Cellular and Species Radiosensitivity. /Bond, Victor P.; Sugahara, Tsutomu (eds.). Tokyo; Igaku Shoin Ltd. (1969).

From Conference on Comparative Cellular and Species Radiosensitivity in Animals, Kyoto, Japan. See CONF-680518.

Since the most significant effect of whole-body irradiation observed in the gastrointestinal tract of mammals is denudation of the mucosa resulting from a disruption of the cell renewal system, an understanding of species and strain differences in recovery mechanisms centers around the kinetics of mucosal cell populations. With small doses, proliferation is halted for 24 to 48 hr and then resumes to achieve again the balance between production and loss of cells. Even with large doses, proliferation is resumed but may not be adequate to prevent death from the effects of destroying the intact intestinal barrier. Proliferation is observed in continuously irradiated animals. Strain and species differences in recovery patterns have not been well investigated. What differences are documented do not alone appear to explain differences in radiosensitivity since damage to other systems is critical in the recovery of the animal. (auth)

12295 THEORETICAL AND PRACTICAL ASPECTS OF MODELS EXPLAINING GASTORINTESTINAL DEATH AND OTHER LETHAL RADIATION SYNDROMES. Lushbaugh, Clarence C. (Oak Ridge Associated Universities, Tenn.). pp 288-97 of Comparative Cellular and Species Radiosensitivity. /Bond, Victor P.; Sugahara, Tsutomu (eds.). Tokyo; Igaku Shoin Ltd. (1969).

From Conference on Comparative Cellular and Species Radiosensitivity in Animals, Kyoto, Japan. See CONF-680518.

Kinetic models describing lethal radiation syndromes can be useful even when they oversimplify the system, and draw unwarranted conclusions concerning modes of death. The gastrointestinal (G.I.) and central nervous system (CNS) syndromes are examples of this. In the CNS Syndrome, cerebral damage is presumed but not demonstrable. In the G.I. Syndrome, the coincidence of intes-

tinal denudation with time of death has led to the assumption that the bare submucosa must leak intolerable amounts of fluids and electrolytes. Attempts to demonstrate such losses by tracer methods show conservation of fluid and decreased electrolyte turnover rates. Neutron activation analysis of organs and tissues of irradiated rats shows that large shifts in intra- and intercellular sodium distribution occur without loss of whole-body sodium. These findings, along with other evidence suggest that the widely accepted concept of the G.I. Syndrome based on kinetic studies of irradiated intestinal epithelium is either too simplified or restrictive. Some pathologic and bacteriologic studies suggest that G.I. death may be a fulminant form of hematopoietic death. At these high levels of radiation, all stem cells may be damaged and repair prevented or fatally impaired. Irreparable vascular damage also may have a larger role in these syndromes than presently accepted. (auth)

12296 LOCALISATION OF IRRADIATION DAMAGE IN RAT SEMINIFEROUS TUBULES. Hall, E. R.; Hupp, E. W. (Texas Woman's Univ., Denton). Nature (London); 225: 85-6(3 Jan 1970).

In testes of animals irradiated during fetal or early postnatal life lack of adjoining active and inactive tissue within a seminiferous tubule might be a barrier to recovery of activity. In the studies described serial longitudinal sections of isolated fragments of rat seminiferous tubule were examined histologically to determine whether the single tubules contained both active and inactive tissue. The rats were irradiated on day 17 post coitum or day 1 post partum and killed at various ages from 100 to 264 days. The criterion adopted for activity was the presence of spermatocytes. Cobalt-60 (150 to 170 R) was employed for the irradiation. More than half of the fragments analyzed were fully active, and very few were completely inactive. Junctions were observed between active and inactive tissue; in addition small areas of inactive tissue surrounded by active tissues were found. The results indicate that irradiation during late prenatal or neonatal life has different effects in different parts of the seminiferous tubule. There may be completely active or inactive tubules in irradiated rat testes, but the investigation showed that active and inactive tissue can be found within the same tubule. (UK)

12297 GASTRIC FUNCTION CHANGES FOLLOWING EXPERIMENTAL ROENTGENOTHERAPEUTIC IRRADIATION OF THE ORAL CAVITY. Golubev, Yu. S. (Inst. of Normal and Pathological Physiology, Moscow. Moscow Medical Stomatological Inst.). Med. Radiol.; 14: No. 11, 19-26(Nov 1969). (In Russian).

Secretory and motor functions of a stomach following a multiple irradiation of the oral cavity with x rays in a summary dose of 5000 to 5500 R were studied in a chronic experiment on 4 dogs. A reduced secretion of the total amount of the gastric juice, declined acidity, and proteolytic activity were noted. The changes proved most pronounced in secretory reactions to a sham meat feeding, as compared to histamine. The rhythm of the periodic motor activity of the stomach became accelerated due to the shortening of the relative rest phase. Interrelations between the secretory and motor functions of the stomach were derived. Postirradiation restoration occurred in 2 to 3 months. (auth)

12298 INFLUENCE OF X-IRRADIATION ON ENZYME INDUCTION: PHOSPHOENOLPYRUVATE CARBOXYKINASE IN THE LIVER OF IRRADIATED MICE. Berndt, J.; Brecht, I.; Kofler, E. (Univ., Freiburg i. B.). Z. Naturforsch.; 24b: 1534-7(Dec 1969).

Normal or adrenalectomized mice were whole-body x irradiated with 690 to 4,000 R either after hydrocortisone administration or during a 24 hr fasting period, and phosphoenolpyruvate (PEP) carboxykinase activity measured after the appropriate time. The results show that the induction of PEP carboxykinase is not affected by the irradiation, neither in hormone-treated nor in fasting normal or adrenalectomized mice as compared to the controls. These findings support the assumption that the protein synthesizing system in the living cell is very resistant to ionizing radiation. (auth)

12299 TRANSFORMING AND INHIBITING ACTION OF X-RAYS ON THE DEVELOPMENT OF RUDIMENTAL SPURS IN CHICK EMBRYOS. Puchkov, V. F. (Inst. of Experimental Medicine, Leningrad). Byull. Eksp. Biol. Med.; 68: No. 9, 101-4(Sep 1969). (In Russian).

Development of rudimental spurs has two marked radiosensitive periods, irradiation during which leads to different results: transformation of spur rudiment into a scale (irradiation on the 8th to 9th day of incubation) or suppression of spur development (irradiation on the 10th day of incubation). (auth)

12300 EFFECTS OF TOTAL- (PARTIAL-) BODY IRRADIATION ON HELMINTHIC INFECTIONS. Casarosa, L. (Univ., Pisa, Italy). pp 105-15 of Isotopes and Radiation in Parasitology. Vienna; International Atomic Energy Agency (1968).

From Meeting on the Use of Isotopes and Radiation in Study and Control of Parasitic Diseases, Vienna, Austria. See STI/PUB-181; CONF-670738.

The effects of irradiation of the body on sensitivity and resistance to viruses and schizomycetes have been studied on numerous occasions following the discoveries of L. Hectoen. This is a complex problem of which various aspects still remain to be explained, for example the effects of such important factors as the nature of the radiation and the form in which it is administered, the lapse of time between injection of the antigen and irradiation, and so on. In the sphere of microbiology numerous authors have conducted research on the effects of irradiation of the body on natural or acquired immunity. On the other hand, the effects of irradiation of the body on animals suffering from helminthic parasitization have not been extensively investigated. Interesting results have been obtained from studies carried out on animals previously immunized, irradiated and subjected to post-irradiation tests, such as titration of the antibodies or control contamination. These studies reveal partial or total loss of acquired immunity following exposure to high doses. The investigations carried out relate to whole-body exposure to x-rays ($LD_{50/90}$) of guinea pigs parasitized after irradiation with 1500 embryonated eggs of Ascaris suum. The results are in agreement with those obtained by other workers. The mortality among the guinea pigs first irradiated and then parasitized proved to be very high during the first ten days, autopsy showing serious pulmonary haemorraghias. In the case of guinea pigs irradiated but not parasitized the mortality was lower (50% in 30 days); zero mortality was observed in guinea pigs parasitized but not irradiated. Among the irradiated animals, the migration of larvae in the liver and lungs was at least as rapid as in the control animals which had been parasitized only; the number and size of the larvae were the same as in the control animals. (auth)

12301 RADIATION FRACTIONATION AS APPLIED TO MURINE COLONY-FORMING CELLS IN DIFFERING PROLIFERATIVE STATES. Chaffey, John T.; Hellman, Samuel (Harvard Medical School, Boston. Yale Univ., New Haven). Radiology; 93: 1167-72(Nov 1969).

Mice were given whole-body x irradiation according to different fractionation schemes. Endogenous spleen colonies were counted nine days later. Results indicate that colony numbers remain constant when receiving 200 R daily fractions at least to seven fractions, apparently because the proliferation of colony-forming cells between fractions is equal to the cell depletion. Unequal fractions of 250 R plus 500 R, separated by time periods of up to ninety-six hr, resulted in fewer colonies than did the same doses in the reverse order. This is interpreted as being due to a proliferative response being initiated by the cell depletion resulting from a high initial dose, but not by an initial dose of 250 R. This may be significant in normal cell renewal systems, where a high reserve capacity for cell proliferation exists. On the other hand, colony-forming cells derived from transplanted bone marrow that was already rapidly proliferative did not show this difference with unequal fractions, presumably because the proliferation was already maximal and thus could not be increased further. (auth)

12302 RADIATION INDUCED AVOIDANCE BEHAVIOR TRANSFER BY BRAIN EXTRACTS OF MICE. Moos, W. S.; LeVan, H.; Mason, B. T.; Mason, H. C.; Hebron, D. L. (International Atomic Energy Agency, Vienna). Experientia; 25: 1215-19(15 Nov 1969).

Behavior changes were observed in untrained mice following injection of a small amount of brain material of saccharin-preference conditioned and x-irradiated mice. Avoidance of saccharin solution developed and the behavior was very similar to that of saccharin-preference conditioned animals after irradiation. (tr-auth)

12303 METASTASIS FOLLOWING RADIOTHERAPY IN HYPERBARIC OXYGEN. Evans, John C. (Duke Univ., Durham, N. C. Veterans Administration Hospital, Durham, N. C.). Radiology; 93: 1155-7(Nov 1969).

Following radiotherapy in hyperbaric oxygen there were reports of an apparent slight increase in distant metastases. This possibility was examined experimentally in chemically induced squamous skin cancer in mice, by routine sectioning of the lungs following radiation therapy. Lung sections were examined from 295 mice, two months after a single radiation treatment. Fifty of these were treated in oxygen at 2 atmospheres absolute pressure. Twenty % of the mice treated in hyperbaric oxygen had lung metastases compared to 14% of those treated in air. This difference is

not statistically significant ($p > 0.1$) and is readily explained by a high percentage of anaplastic cancers in the hyperbaric oxygen group. (auth)

12304 THE INFLUENCE OF THE BONE MARROW ON THE REPOPULATION OF THE THYMUS IN X-IRRADIATED MICE. Blomgren, H. (Karolinska Institutet Medical School, Stockholm). Exp. Cell Res.; 58: 353-64(Dec 1969).

A quantitative cellular study of the irradiated mouse thymus and bone marrow has been presented. The bone marrow cells were classified into two populations, according to their volume. One of these cell populations is mainly composed of lymphocytic and the other of granulocytic cells. These two populations showed dissimilar repopulation patterns after whole-body irradiation. The thymus cell population exhibited a repopulation pattern closely resembling that of the bone marrow lymphocyte population, both after whole- and partial-body irradiation. Bone marrow shielding during a second irradiation, 8 to 26 days after the first one, accelerated the thymus repopulation if the second dose was given at a time when the bone marrow was composed predominantly of small cells. An attempt was also made to purify the bone marrow lymphocytes by treating bone marrow cells in vitro with desoxycholate. It was observed that transplantation of desoxycholate-resistant cells into lethally irradiated mice induced an earlier repopulation of the thymus than an equal number of normal bone marrow cells. (auth)

12305 IODINE FIXATION BY BLOOD PROTEIN DURING RADIATION SICKNESS. Turakulov, Ya. Kh.; Ablyaeva, N. Kh. (Inst. of Biochemistry, Tashkent). Uzb. Biol. Zh.; No. 5, 53 (1969). (In Russian).

Thyroid gland condition and iodine fixation by blood plasma protein in white male rats exposed to 400 R ^{60}Co γ rays showed considerable increase of the amount of iodine fixation at three days after exposure. However, serum obtained from the rats at 5, 7, 10, 15, and 20 days after exposure revealed a considerable drop in the amount of iodine fixed in blood plasma protein. (R.V.J.)

12306 ON THE MECHANISM OF CHANGES OF ADHESIVENESS AND AGGREGATION OF BLOOD PLATELETS IN ACUTE RADIATION SICKNESS. Baluda, V. P.; Sushkevich, G. N.; Zhukova, N. A.; Khnychev, S. S.; Shiryaev, V. V. (Inst. of Medical Radiology, Moscow). Byull. Eksp. Biol. Med.; 68: No. 10, 35-9(Oct 1969). (In Russian).

Investigations carried out on 330 Wistar rats show that during acute radiation sickness along with the decrease of the number of blood platelets with a shift of the thrombocytogram to the right there is a decrease in the adhesive and aggregation properties of blood platelets. Studies in vitro and in vivo of the functional properties of blood platelets of irradiated animals after addition of thrombocyte free plasma or blood serum of healthy rats show that the upset of functional properties is due not so much with the morphological changes of the platelets, but rather to the decreased activity of the plasma factor which participates in the adhesion and aggregation of blood platelets. Opinion is expressed that changes of adhesiveness and aggregation of blood platelets in rats during acute radiation sickness are due to the fall of activity of the factor XIII. (auth)

12307 CORRELATION BETWEEN THE SPECIFIC WEIGHT, INDEX OF REFRACTION, AND SMELL OF THE URINE OF IRRADIATED RATS. Scoppa, P. (CCR–EURATOM, Ispra, Italy). Boll. Soc. Ital. Biol. Sper.; 44: 2219-22(31 Dec 1968). (In Italian).

The correlation between the specific weight, index of refraction, and smell, which is used as an indirect measurement of the total solute present in urine, is valid in the case of rats exposed to a sublethal dose of x rays. The use of pair-fasted controls made it possible to verify that the relations between these parameters maintain their linearity for the urine from rats having a reduced food ration. (tr-auth)

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Refer also to abstracts 11952, 11984, 11989, 12050, 12097, 12202, and 12281.

12308 (EXEP-690501) RELATION OF RADIOACTIVE FALLOUT TO LEUKEMIA AND FETAL MORTALITY: A RECONSIDERATION. Greenwald, Peter; Kinch, Sandra (New York State Dept. of Health, Albany). [1969]. 9p. Dep. CFSTI.

A critical reconsideration of evidence purporting to show a relation between radioactive fallout and leukemia and fetal mortality was made. Crucial to the analysis was the leukemia and mortality trends in certain counties of New York during the 1950's. Using Vital Statistics and State Cancer Registry data, the New York State Department of Health analyzed the reported study and the data upon which it was based. Discrepancies in the analysis of the data are discussed. It was concluded that the basic data from which the massive schema for cause and effects were developed contained errors and that the data were incorrectly used. (C.O.)

12309 THE TOPICAL USE OF FLUOCORTOLENE ESTERS (TRIMETHYLACETATE AND CAPRONATE) IN THE TREATMENT OF PROCTITIS CAUSED BY IRRADIATION. Vizzone, Antonio; Calugi, Alberto; Ramadori, Pietro (Univ., Rome). Clin. Ter.; 43: 35-47(Oct. 15, 1967). (In Italian).

16 cases of radioinduced proctitis treated with a new preparation with topical action (suppositories and ointment) were reported. The patients were treated with a combination of the trimethylacetate and capronate esters of fluocortolene (which is a derivative of corticosterone with remarkable antiflogistic action), with a drug with antibacterial action (esachlorophene), with an antihistamine (clemizol undecylate), and with an anesthetic (cincocaine chlorhydrate). It was concluded, on the basis of symptomatic improvements obtained endoscopically and histologically, that radiation proctitis is highly sensitive to this type of treatment and that therapy continued over a longer period of time can completely cure the symptoms. (tr-auth)

12310 DENTAL CARIES FROM RADIATION THERAPY. Pansch, J. L.; Callaghan, Nathan R.; Appleby, Ralph C. Iowa Dent. J.; 55: 40-1(Jun 1969).

A case of tooth demineralization was observed following irradiation of a tumor site in the nasopharynx. Clinically, this case demonstrated irradiation of a tumor in the nasopharynx through both parotids and submaxillary glands, xerostomia resulting from partial destruction of these glands, lowered pH in the oral cavity due to a lack of saliva that decreased its buffering capacity, demineralization of clinical crowns of the teeth due to a lowered pH, and complete edenulation of patient with uneventful healing. (auth)

12311 VOLUME DOSE AND INTEGRAL DAMAGE IN VARIOUS RADIOTHERAPEUTIC TECHNIQUES. Hattori, Hiroyuki; Kitabatake, Takashi (Niigata Univ., Japan). Strahlentherapie; 138: 404-9(Oct 1969).

The integral damage, a new indicator for evaluation of radiation damage in radiotherapy, was defined based on synthesis of integral dose and dose-effect relationship. Four types of dose-effect relationships were assumed. For these dose-effect relationships the integral damage was calculated in cases of conformation, rotation, and two-opposing treatment techniques for cervical cancer using a 6 MeV linear accelerator x-rays. The values of the integral damage ratio obtained for three techniques were compared and it was concluded that conformation technique is most suitable for clinical use from the point of view of radiation damage. (auth)

12312 LATER RESULTS OF ^{131}I TREATMENT OF HYPERTHYROIDISM IN 73 CHILDREN AND ADOLESCENTS: 1967 FOLLOWUP. Starr, Paul (White Memorial Medical Center, Los Angeles); Jaffe, Henry L.; Oettinger, Leon Jr. J. Nucl. Med.; 10: 586-90(Sep 1969).

Clinical and pathological observations on persons who had underdone ^{131}I radiotherapy for hyperthyroidism as children are reported. Observation periods ranged from 6 to 18 years. A table lists data for each patient. Seven children had palpable nodular thyroid tissue a few years after the isotope treatment; four of these were subjected to subtotal thyroidectomy. Of the 56 females in the group, 28 had a total of 52 normal children and six of the 17 males had 17 normal children. It appeared that hypothyroidism had developed in the majority of these people since many were treated with thyroid hormone therapy. It is concluded that maintenance thyroid hormone therapy, preferably sodium levothyroxine, should be started in all children following ^{131}I therapy without waiting for this permanent deficiency to develop. (C.O.)

12313 QUANTITATIVE ASSESSMENT OF THE SKIN REACTIONS IN ELECTRON-BEAM THERAPY OF TUMORS OF THE NERVOUS SYSTEM. Smirnov, R. V. (Leningrad Inst. of Research in Neuro-Surgery). Med. Radiol.; 14: No. 11, 46-50 (Nov 1969). (In Russian).

The article presents the results of observations of the skin reactions in 55 patients with tumor of the central nervous system or spine, who were treated by means of electron beam (an energy of 10 to 20 MeV). The mean epilation dose of irradiation (in fractional–intensive irradiation) was 1080 Rad. The skin erythema commonly developed after the effect of 3000 to 4000 Rad on the field in patients over 20 years old or 2000 to 3000 Rad in patients under 20 years. In the process of treatment in doses of 3000 to 5000 Rad exudative epidermitis appeared. During treatment there

developed a marked pigmentation which did not disappear for several months. (auth)

12314 OSTEOGENIC SARCOMA FOLLOWING RADIOTHERAPY FOR RETINOBLASTOMA. Yoneyama, Tatsuo; Greenlaw, Robert H. (Univ. of Kentucky, Lexington). Radiology; 93: 1185-6(Nov 1969).

An autopsy case of osteogenic sarcoma with distant metastases following x-radiotherapy for retinoblastoma on a 17-year-old boy is reported. After enucleation of the right eye at the age of ten months, radiotherapy was given from two ports. The total dose estimated in air at each treatment port was 6,800 R. Pathologically confirmed osteogenic sarcoma arose from the site of irradiation with the latent period of fourteen years and ten months. Nine cases of such conditions were reported in the literature, that were reviewed in comparison with this case. (auth)

12315 RADIOINDUCED DOUBLE CANCER. Papillon, J.; Guinet, P.; Maillet, P.; Amiel, M. J. Radiol., Electrol., Med. Nucl.; 50: 687-90(Oct 1969). (In French).

A case is described of thyroid carcinoma in a 27 year old woman who had been treated with radium at the age of 9 months for a tuberous angioma in the region of the thyroid and another in the left breast. Two years later a carcinoma of the left breast was discovered. The hazards of radiotherapy for benign diseases are emphasized. (auth)

12316 RADIOSARCOMAS OF BONE. Clement, R.; Amalric, R.; Rathelot, P.; Dajoux, R.; Spitalier, J. M.; Lieutand, R.; Varette, I.; Bonneau, H.; Cesarini, J. P. J. Radiol., Electrol., Med. Nucl.; 50: 721(Oct 1969). (In French).

The high incidence of radioinduced carcinomas, sarcomas, and leukemia in man is discussed. It is pointed out that many of these represent unexpected and late complications of radiotherapy. Previous reports in the literature of radiosarcomas of bone are reviewed. In 40% of cases radiation acted on healthy bone tissue located in the path of radiation used for treatment of deep cancer. It was estimated that the incidence of radiosarcoma of bone was one in 10,000 cases of irradiated carcinoma surviving five years or more. A very low incidence of radioinduced bone sarcoma was noted following radiotherapy of mammary carcinomas and of cervical carcinomas considering the large number of these cases treated. It is recommended that benign tumors in young individuals should not be treated by radiation and in adults moderate doses should be used and should not be repeated. (H.L.W.)

12317 STUDY OF A CASE OF RADIOINDUCED CUTANEOUS CANCER OF BOTH HANDS. Papillon, J.; Chassard, J. L.; Clermont, A.; Ibarra, S. J. Radiol., Electrol., Med. Nucl.; 50: 750-1(Oct 1969). (In French).

A case of radioinduced cancer of the skin of a 53 yr old woman is described. In 1943 an eczema appeared on both hands. Radiotherapy was administered in 1947 after other treatments had failed. The total dose was sufficient to cause radiodystrophy with retracted fingers and discolored skin. In 1961 an ulcerous and neoplastic condition developed on the left hand, and an amputation was performed in 1962. Later a similar condition appeared on the right hand; a biopsy revealed a malpighian spinocellular carcinoma. The hazards of using radiation for therapy of chronic conditions, especially those of the skin, are emphasized. (H.L.W.)

Radiation Effects on Plants

Refer also to abstracts 11966, 11967, 12040–12043, 12046, 12047, 12052, 12054–12056, 12219, and 12229.

12318 (ORO-672, pp 142-56) CONTROL AND MODIFICATION OF SEED RADIOSENSITIVITY. Conger, B. V.; Constantin, M. J. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

The γ radiosensitivity of barley seeds under controlled conditions of dose rate, seed moisture, temperature, and oxygen abundance was studied. In general it was found that the radiosensitivity was greatest at very low and very high levels of seed water content or oxygen abundance. Study was started on determination of the sensitivity of seed to 14.7-MeV neutrons. Data from all studies are presented in tabular form. (C.O.)

12319 (ORO-672, pp 167-77) FALLOUT RADIATION AND CROP PRODUCTIVITY. Siemer, E. G.; Constantin, M. J. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

The effects of ^{60}Co γ radiation on yield reduction for barley, corn, oats, rice, soybeans, and wheat following sublethal doses to plants at various stages of development were investigated and results are summarized and discussed. Data are presented in graphic and tabular form. (C.O.)

12320 (ORO-672, pp 178-83) RADIOSENSITIVITY IN SHOOT APICAL MERISTEMS. Graham, E. T. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

Results from identification studies on cellular sites of γ-radiation injury in shoot apical meristems (carnation, and coleus) and studies on the mechanism in injury are reported and summarized. Histological procedures formed the main analysis approach. Damage appeared equally intense in tunica and corpus cells. The only relation between radiosensitivity and apical anatomy was the obvious concentration of damage in the promeristem. Starch content was reduced and was considered to be due to the sudden onset of the response in advance of the first appearance of necrotic cells in the promeristem. (C.O.)

12321 INFLUENCE OF PREPLANTING GAMMA-IRRADIATION ON THE GERMINATION RATE OF SEEDS AND THE SURVIVAL OF HEMP SEEDLINGS. Zhatov, A. N.; Kovalenko, V. M. Radiobiologiya; 9: 769-72(1969). (In Russian).

Laboratory and field investigations established that low doses of γ-rays (0.5 to 5 kR) increase the energy of germination and field germination rate of hemp seeds. Hemp seeds irradiated with relatively high doses and stored under laboratory conditions for from 10 days to 15 months did not show any recovery of field germination rate. (tr-auth)

12322 PERIODS OF REALIZATION OF POTENTIAL RADIATION DAMAGES IN YEAST ORGANISMS AND THEIR RELATIONSHIP TO DNA SYNTHESIS AND NUCLEAR DIVISION. Sokurova, E. N.; Fofanova, K. A. (Inst. of Medical Radiology, Obninsk, USSR). Radiobiologiya; 9: 737-41(1969). (In Russian).

The question of the periods of realization of potential radiation damages is extremely important for investigating the mechanism of the formation of radiation damages and the mechanism of postradiation recovery of cells. There are data indicating that the loss of the ability of yeast cells for recovery from radiation damages occurs during the first postradiation budding [1,2]. The question arises of whether this loss of ability of the cells for recovery is associated with DNA replication in the irradiated cells or with processes associated with the division of the nuclei. The aim of the present work included an elucidation of this question. (tr-auth)

12323 EFFECT OF THE DOSE RATE IN THE RADIATION OF PEA SEEDS IN VARIOUS PHASES OF GERMINATION. Gudkov, I. N. (Inst. of Plant Physiology, Kiev). Radiobiologiya; 9: 772-3(1969). (In Russian).

It was shown that in the activation of processes of metabolism characterizing the transition of seeds from the state of dormancy to germination, together with an increase in the radiosensitivity, an increase in the dose reduction factor (DRF) is observed as the dose rate is increased. The maximum value of the DRF was reached after irradiation of 48 hr seedlings, distinguished by the highest radiosensitivity. The data obtained indicate that as metabolism is intensified, accompanied by an increase in the radiosensitivity, processes of recovery in the irradiated organism are also intensified. (tr-auth)

12324 DEPENDENCE OF POSTRADIATION RECOVERY ON THE CONTENT OF HIGH-ENERGY COMPOUNDS IN GAMMA-IRRADIATED CELLS AND THE INCUBATION MEDIUM. Mosin, A. F.; Petrova, K. M. (Inst. of Medical Radiology, Obninsk, USSR). Radiobiologiya; 9: 728-32(1969). (In Russian).

The preliminary exhaustion of the endogenous reserves of high-energy compounds in yeast (Saccharomyces vini, Megri 139B) before irradiation and their subsequent incubation under conditions suppressing the formation of these substances does not prevent postradiation recovery of the cells. Under anaerobic conditions without fermentation substrates, exogenous ATP has no influence on the survival of irradiated yeasts. Under aerobic conditions and under conditions of anoxia with glucose, the addition of ATP to the medium produces a decrease in the level of recovery in connection with the beginning of mitosis of the cells, stimulated by ATP. Penetrating into the cells, ATP does not perform energy-supplying functions, but can be used as a source of amino nitrogen and respiration substances. (tr-auth)

12325 DEPENDENCE OF THE RELATIVE BIOLOGICAL EFFICIENCY OF HIGH-ENERGY BREMSSTRAHLUNG ON THE DEPTH IN A PHANTOM. Staehler, F.; Zywietz, F.; Ewert, W.; Kuenkel, H. A. (Univ., Hamburg). Z. Naturforsch.; 24b: 1633-40(Dec 1969). (In German).

The relative biological efficiency (RBE) of 6-GeV-bremsstrahlung on 3-days-old seedlings of Vicia faba was investigated with the Deutsches Elektronen Synchrotron. Dosimetry was carried out by means of the butanol-sensitized Fe^{II}/Fe^{III}-reaction. In a Lucite-

phantom we observed an increase of the RBE from 0.65 at the surface to values of about 2 at depth of 40 cm. As changes of that order of magnitude are doubtless beyond the limits of the maximum experimental error we suppose that production of heavy particles by nuclear reactions such as (γ,n) or (γ,p) in deeper layers of matter might cause an increase of the linear energy transfer of the beam. (auth)

12326 MODIFICATION OF BARLEY SEED RADIOSENSITIVITY WITH MICROWAVE RADIATION. I. EFFECT OF MOISTURE CONTENT AND POST-RADIATION HYDRATION. Kamra, Om P.; Kesavan, P. C. (Dalhousie Univ., Halifax, Nova Scotia). Radiat. Bot.; 9: 443-8(Nov 1969).

Microwave radiation treatment of 50 sec duration at a continuous frequency of 2450 MHz and a power of 9.5 W restores post-radiation injury in dormant barley seeds. Microwave restoration of damage is maximum in dry seeds (3 per cent moisture) and negligible in moist seeds (11 per cent moisture). Data indicate that the component of damage restored by microwave radiation under the conditions of the experiment is the oxygen-dependent post-radiation effect. (auth) (UK)

12327 CONTRIBUTIONS TO RADIATION STIMULATION. II. THE EFFECT OF LENGTH OF DAY ON THE RADIATION INDUCED INCREASE IN GROWTH OF LEMNA MINOR L. Feldmann, A. (Kernforschungsanlage, Juelich, Ger.). Radiat. Bot.; 9: 459-71(Nov 1969). (In German).

In Lemna minor day length influences an X-ray-induced increase of growth. Two reaction maxima were obtained for the formation of fronds as well as for fresh, dry and ash weights. The maxima were obtained with 6 hr (short day) and 16 hr (long day) photoperiods. They showed quantitative and qualitative differences. In no case was a stimulating effect entirely absent. At medium day lengths of 8-12 hr no changes occurred in the fresh, dry and ash weights of single fronds compared to the control. In short-day experiments (4 and 6 hr) weight and size of single fronds increased; in long-day experiments (16 hr), however, there was a slight tendency towards decrease in weight. Day length to a large extent modified the range of stimulation. The first stimulation response was consistently observed below 50 R, while the final point was shifted by at least a factor of two for all criteria investigated. Depending on the day length an increase or decrease of growth was caused by the same dose. High threshold values were linked with a strong stimulation and vice versa. (auth) (UK)

12328 EMBRYO AND ENDOSPERM DEVELOPMENT AFTER X-IRRADIATION OF THE FRUIT NODULES OF ARABIDOPSIS THALIANA (L.) HEYNH. Gerlach-Cruse, Doris (Univ., Erlangen, Ger.). Radiat. Bot.; 9: 433-42(Nov 1969). (In German).

After X-ray irradiation (56 kV, 2 mA, filter 0.1 mm Al) of the pistils in Arabidopsis thaliana and subsequent pollination of the stigmata with non-irradiated pollen, the following aberrations can be observed: on the one hand, the caryogamy between female and male nucleus may be inhibited, on the other, dispermous or trispermous fertilization of the ova may take place. Compared to the controls, the embryos of the ovules show different stages of development after irradiation of the pistils. The widest range of variation was observed eight days after pollination. With increasing dose the number of embryos developing decreases. Degenerations are only detectable after several divisions of embryo and endosperm; the cells of the embryo proper degenerate earlier and more often than those of the suspensor. Numerous embryos develop only into the globular stage. Up to the early globular stage the development of the embryo is independent of that of the endosperm. From the fourth day after pollination aberrant divisions can be observed in the suspensor. An increase in divisions running vertically to the longitudinal axis of the embryo often results in an abnormally increased number of suspensor cells. Additional divisions running parallel to the longitudinal axis lead to flattened or bulky suspensors. If only a few cells of the suspensors are involved in these divisions, the division products will often be similar to embryos in the quadrant stage. Compared to the controls, the number of endosperm nuclei is reduced after irradiation of the pistils. Degeneration of the endosperm is more likely to occur with high doses than with low doses. (auth) (UK)

12329 RADIOSENSITIVITY AND POLYPLOIDY IN SOME NON-TUBER BEARING SOLANUM SPECIES. Yamagata, H.; Kowyama, Y.; Syakudo, K. (Kyoto Univ.). Radiat. Bot.; 9: 509-21(Nov 1969).

Twenty-two non-tuber-bearing species of the genus Solanum were investigated cytologically, and their responses to chronic gamma-ray and acute x-ray treatments were studied in terms of induced pollen sterility, growth inhibition and chromosomal aberration, paying special attention to their ploidy levels. The materials used included 2x, 4x and 6x species. The average interphase chromosome volume (ICV) decreases with increasing ploidy. Chronic irradiation of plants revealed no correlation between radiosensitivity and ploidy level, whereas a greater resistance of higher polyploids was observed after acute irradiation of seeds. On the other hand, considerable interspecific differences of sensitivity were seen even in the same ploidy level regardless of irradiation method. The results suggest that the interspecific difference might be mainly attributed to the genotypic constitution specific for each species rather than to the ICV or genetic redundancy. "Revised seedling height" was proposed as an adequate index in determining radiosensitivity based on growth inhibition. (auth) (UK)

12330 RADIATION INDUCED GROWTH ABNORMALITIES IN VEGETATIVE SHOOT APICES OF CAPSICUM ANNUUM L. IN RELATION TO CELLULAR DAMAGE. Iqbal, J. (Punjab Univ., Lahore). Radiat. Bot.; 9: 491-9(Nov 1969).

Seedlings of Capsicum annuum L. (long-fruited variety) were irradiated acutely with gamma rays (^{60}Co) at cotyledonary, 4-leaf, 8-leaf and 12-leaf stages of development. Seedlings were exposed to 1, 2, 3, 4, 5, 7.5 and 10 kR and were analyzed for growth abnormalities of the shoot apex (resulting from cellular damage). Mitotic frequency was greatly reduced at 1 to 5 kR and was completely suppressed at 7.5 and 10 kR. Periclinal divisions which were absent in central cells of tunica 1 and 2 in control plants were occasionally found in irradiated seedlings, particularly those at cotyledonary stage. An increase in the size of cells of the promeristem following radiation was also noticed. Abnormal presence of isolated vessels in some of the completely disorganized shoot apices was also found. The percentage of cell death and suppression of mitoses at different exposures are important causal agents of the radiation-induced growth abnormalities. (auth) (UK)

12331 RESISTANCE OF BLUE-GREEN ALGAE TO ^{60}Co GAMMA RADIATION. Kraus, Marjorie P. (Univ. of Delaware, Newark). Radiat. Bot.; 9: 481-9(Nov 1969). (NYO-3383-15).

Many characteristics of blue green algae suggest that they should be excellent organisms for the investigation of biological interaction with radiation, particularly ionizing radiation. Therefore, the relative resistance to gamma radiation from a ^{60}Co source was measured for 23 cyanophycean algae. Since the organisms represent a wide range of cell types it was necessary to use dry weight as the end point for viability determination. Using the radiation resistant bacterium Micrococcus radiodurans as a primary standard and the bacterium Sarcina lutea as a secondary standard, the algae were compared with one another and with S. lutea using a dry weight end point; S. lutea was also compared with M. radiodurans on a colony count basis. The algae showed a wide range of radiation resistance and were grouped into three categories: (1) low resistance, with an LD_{90} of less than 400 krads, for example, Microcystis aeruginosa, Anacystis nidulans and some species of Schizothrix calcicola; (2) moderate resistance (equal or better than M. radiodurans) with an LD_{90} of more than 400 krads but less than 1200 krads, for example, Oscillatoria brevis, Anabaena variabilis and Scytonema hoffmannii; (3) high resistance, with an LD_{90} of greater than 1200 krads, for example, Plectonema boryanum, Lyngbya estuarii, Nostoc muscorum and Microcoleus vaginatus. (auth) (UK)

12332 SEEDLING IRRADIATION OF GAMMA-PLANTLETS: DEMONSTRATION AND EXPLANATION OF A LEAF GROWTH STIMULATION. Haber, A. H.; Foard, D. E.; Triplett, L. L. (Oak Ridge National Lab., Tenn.). Radiat. Bot.; 9: 473-9 (Nov 1969).

A dose of 500 krads of gamma rays to the dry seeds ("seed irradiation") prevents mitosis during germination of wheat seedlings; such seedlings are called "gamma-plantlets." Their growth is relatively little affected by increasing the dose of the seed irradiation beyond 500 krads. As growing seedlings, however, gamma-plantlets are sensitive to additional irradiation ("seedling irradiation"). Leaf growth is reduced by seedling irradiation doses of 50 krads in intact plants and 25 krads in seedlings excised from the endosperm. The effectiveness of a given dose is decreased by dose fractionation. Consequently some repair mechanisms survive the heavy seed irradiation and can operate independently of processes directly or indirectly involving cell division. Growth stimulation was observed in the first leaf, not the coleoptile, after a seedling irradiation dose of 25 krads was given to intact gamma-plantlets. Similarly there was a stimulation of second leaf growth but not of stem growth. These growth stimulations were absent when exogenous nutriments were substituted for the endosperm immediately following the seedling irradiation. Associated with the leaf growth stimulation in the intact gamma-plantlets was an accelerated breakdown of endosperm starch to soluble carbohydrate without any greater amylase ac-

tivity. Comparison of gamma-plantlets from two different varieties of wheat disclosed an apparent correlation between the presence of the leaf growth stimulation and faster breakdown of endosperm starch resulting from the seedling irradiation. It is suggested that the leaf growth stimulation, which in this system is not masked by certain inhibitory radiation effects (i.e., decreased mitotic activity and nuclear imbalance resulting from division of cells having chromosomal aberrations), results from the more favorable carbohydrate nutrition caused by an apparently nonspecific promotion of endosperm breakdown. (auth) (UK)

12333 PHYSIOLOGICAL PECULIARITIES OF LIVE PINEWOOD CELLS AFTER IRRADIATION OF CAMBIUM. Lazda, E. E.; Odintsov, P. N. (Inst. of Pulp Chemistry, Riga). Latv. PSR Zinat. Akad. Vestis; No. 9, 61-71(1969). (In Russian).

A study was made of the live part of 40-year-old pinewood formed after gamma-irradiation (31,000, 18,000 and 9,000 R doses). Physiological condition and post-irradiation changes within pathological parenchyma cells, pathological resin ducts and medullary rays were investigated by cytochemical means. Localization of resinous matter, condition of reserve matter (fats and starch), as well as the emergence of polyphenolic matter in the cytoplasm of parenchymal cells were determined. A study was made also of the process of epithelial and parenchymal cell atrophy and of the corresponding changes in cytoplasmic inclusions, structure of nucleus, and cell walls. The results obtained indicated that the action of gamma-irradiation did not cease with discontinuance of irradiation and it caused marked changes in the functioning of cambium and in the metabolic processes of live pinewood tissue. Phenomena caused by irradiation after-effects were analogous to those observed at formation of injured wood in cases of mechanical injury to the tree. (auth)

Radiation Effects on Microorganisms

Refer also to abstracts 11951, 11958, 12037, 12048, 12051, 12058, 12215, 12216, 12219, 12242, 12341, and 12342.

12334 DIFFERENCES IN THE SENSITIVITY OF DIFFERENT STRAINS OF E. COLI TO GAMMA- AND ALPHA-IRRADIATION. Korogodin, V. I.; Myasnik, M. N.; Petin, V. G.; Morozov, I. I. (Inst. of Medical Radiology, Obninsk, USSR). Radiobiologiya; 9: 724-7(1969). (In Russian).

The work was devoted to an analysis of the influence of γ- and α-irradiation on the survival of various strains of E. coli, cultured under different conditions before irradiation. It was shown that there are definite specific patterns in the responses of the cells of each strain to irradiation, as well as a dependence of these responses on the type of radiation and conditions of culturing. The experimental data together lead to the conclusion that there are difficulties in the generally accepted interpretation of the nature of the radiosensitivity of these strains from the standpoint of the hypothesis of postradiation recovery and damage to repair systems of the cells after irradiation by densely ionizing particles. (tr-auth)

12335 MUTUAL INFLUENCE OF BACTERIA ESCHERICHIA COLI B AND ESCHERICHIA COLI B_{s-1} ON THE SURVIVAL OF T1 BACTERIOPHAGE, SUBJECTED TO UV-IRRADIATION WITHIN THE HOST CELL (THE BACTERIAL LAYER EFFECT). Mosin, A. F.; Petrova, K. M. (Inst. of Medical Radiology, Obninsk, USSR). Radiobiologiya; 9: 782-3(1969). (In Russian).

In experiments with irradiation of T1 phage within cells of E. coli B or E. coli B_{s-1}, followed by inoculation onto a strain of bacteria opposite in ability for host cell reactivation, forming a layer, it was found that the survival of the irradiated phage is determined chiefly by the cells (HCR^-, HCR^+) forming the bacterial layer, and not by the cells in which the phage was before and immediately after irradiation (the bacterial layer effect). Replication of the phage DNA within the host cell, as is indicated by the data of experiments with and without chloramphenicol, apparently is not significant in the manifestation of this effect. (tr-auth)

12336 PRIMARY RADIOTOXINS AND POSSIBLE PROTECTIVE MECHANISMS OF AET. Kuzin, A. M.; Kondratenko, V. G.; Gaziev, A. I.; Yurov, S. S. (Inst. of Biophysics, Moscow). pp 83-93 of Radiation Damage and Sulphydryl Compounds. Vienna; International Atomic Energy Agency (1969). (In Russian).

From Panel on Radiation Damage to the Biological Molecular Information System with Special Regard to the Role of Sh-Groups, Vienna, Austria. See CONF-681069.

The authors take as a starting-point the theory previously formulated by them to the effect that radiation injury to cell genetic structures occurs not only by the direct action of radiation but also by the secondary action of primary radiotoxins. The mutagenic and lysogenic effect of radiotoxins isolated from irradiated tissues is demonstrated on E. coli. Using the data in the literature and the authors' own experiments on the role of AET in protecting developing Misgurnus embryos against gamma radiation, it is shown that the protection mechanism comes into play only above a certain dose threshold and is absent at low irradiation doses. Since it is more probable that radiotoxins play a part at higher doses, it is concluded that the protection mechanism acts against the secondary action of radiotoxins. This conclusion is confirmed by demonstrating that AET affords protection against death from the isolated radiotoxins. Data correlating the radiosensitivity of the tissues and the presence of radiotoxin precursors (which intercept free radicals) are given. The theory is proposed that AET changes the physiological condition of the cell nucleus by making the genetic structures less vulnerable to the action of radiotoxins. Experimental results showing the dependence of the protective action on the cell development phase are cited to corroborate this theory. (auth)

Radiosterilization and Radiopreservation

Refer also to abstract 11989.

12337 (IA-1190, pp 217-33) FOOD AND INDUSTRIAL IRRADIATION. (Israel Atomic Energy Commission, Tel Aviv).

Studies are reported on effects of radiation processing on sprouting and storage qualities of potatoes; marketing of irradiated potatoes; comparison of organoleptic properties of irradiated and fresh potatoes; storage tests on irradiated onions; effects of γ radiation on phenylalanine ammonia-lyase activity and phenolic compound accumulation in citrus peel; preservation of citrus fruit by irradiation; prolongation of post-harvest ripening of avocado pears; prolongation of storage life of strawberries by γ radiation; prolongation of storage life of smoked turkey meat by γ irradiation; preservation of eggs by irradiation; bread preservation by irradiation; radiation effects on grain borer (Callosobruchus maculatus) storage pest; and gamma radioinduced grafting of acrylic acid on starch. (H.L.W.)

12338 (NYO-3733-6) MICROBIOLOGICAL ASPECTS OF RADIOPASTEURIZED CHICKEN. Sixth Quarterly Report. (Hazleton Labs., Inc., Falls Church, Va.). 27 Sep 1968. Contract AT(30-1)-3733. 35p. Dep. CFSTI.

Most experimental observations made with the normal chicken samples used were considered to fall within the expected limits. The most frequent cell types, psychrotrophs, coliforms, and Staphylococcus are effectively reduced by 0.2 Mrad. However, the psychrotrophs are composed of a radioresistant cell type which will always outgrow if given sufficient time. The coliforms appear to develop well at the low temperature of 40°F. However, low dose irradiation effectively reduces this hazard. Staphylococcus may develop into sizable populations at high incubation temperatures, but irradiation can reduce their numbers significantly. The Streptococcus group does appear to multiply at the higher temperatures, as opposed to when the mixed inoculum was used, in which case the levels were relatively stable throughout the incubation period. However, even though the streptococci are more radioresistant than the normal microbial population, its ability to develop can be retarded at 0.2-0.3 Mrad. (auth)

12339 (ORO-3698-3) INOCULATED PACK STUDIES ON LOW-DOSE IRRADIATED MARINE PRODUCTS: SHRIMP. Ward, B. Q. (Miami Univ., Fla. Rosenstiel School of Marine and Atmospheric Sciences). 1 Nov 1969. Contract AT(40-1)-3648. 15p. Dep. CFSTI.

Aerobic packs of penaeid shrimp were inoculated with unusually small numbers of spores of Clostridium botulinum type E, were irradiated with doses of 100 and 200 Krads, incubated aerobically at temperatures of 38, 42, 50, and 72°F, were evaluated to determine spoilage, and were periodically tested for the presence of botulinum toxin. Both temperature and radiation effects on shelf life were observed. A radiation dosage of 100 Krad was superior to both unirradiated controls and to 200 Krad packs. Very small numbers of inoculated spores were capable of eventual toxin generation. The question of non-E botulism in pink shrimp persisted. Under aerobic conditions, shelf-life was commercially practical, and safety factors were adequate. (auth)

12340 (SC-RR-69-857) THE FEASIBILITY OF THERMORADIATION FOR STERILIZATION OF SPACECRAFT. A Preliminary Report. Reynolds, Marcel C. (Sandia Labs., Albuquerque, N. Mex.). Dec 1969. 27p. Dep. CFSTI.

Preliminary data on the feasibility of using combinations of heat and radiation for sterilization of spacecraft are presented. Initial tests indicate that, utilizing relatively low levels of heat and radi-

ation, the technique provides effective bacterial sterilization. The applicability of the technique to a selection of other resistant bacteria, the optimization of temperature/radiation exposures, and the effectiveness on actual spacecraft hardware will be examined in the future. (auth)

12341 (TID-25231) GROWTH AND TOXIN PRODUCTION OF CLOSTRIDIUM BOTULINUM TYPES E, NONPROTEOLYTIC B, AND F IN NONIRRADIATED AND IRRADIATED FISHERIES PRODUCTS IN THE TEMPERATURE RANGE OF 38° TO 50°F. Annual Progress Report. Eklund, M. W.; Poysky, F. T. (Bureau of Commercial Fisheries, Seattle, Wash. Technological Lab.). Jul 1969. Contract AT(49-7)-2442. 33p. Dep. CFSTI.

Following treatment with mitomycin C, cell lysates were examined with the electron microscope and bacteriophages were found for each of the different types of Clostridium botulinum. Procedures are outlined for isolation of bacteriophage for nontoxigenic organisms resembling C. botulinum types B, E, and F and detection of phage using the agar overlay technique. Experiments were conducted on curing nonproteolytic type F C. botulinum of its lysogenic state with ultraviolet light. Studies were conducted on factors in raw irradiated oysters that prevent production or destroy botulinum toxin. (H.L.W.)

12342 SURVIVAL OF CLOSTRIDIUM BOTULINUM SPORES IN FOODS TREATED BY HEAT, IONIZING RADIATION, OR RELATED PROCEDURES. Ingram, M.; Roberts, T. A. (Meat Research Inst., Bristol, Eng.). Ann. Inst. Pasteur Lille; 19: 123-37(1968).

A review of recent literature is presented on the effects of various agents on Clostridium botulinum spores in foods. Resistance of spores of different strains of Cl. botulinum to heat is discussed; a table is presented to show effects of temperatures of 77 to 115°C on spores. Effects of heat on curing ingredients in foods are discussed. Effects of radiation on spores of various strains are reviewed, and factors influencing radiation resistance, such as dose, gases, pH, temperature, and water are discussed. Combined effects of heat and radiation may offer some advantages, but this procedure can not be recommended without further study. Although antibiotics inhibit the growth of Cl. botulinum, their use is not practical because of the large concentrations required and other factors. Effects of combined heat and antibiotics, and combined radiation and antibiotics are also reviewed. (H.L.W.)

12343 PROCEEDINGS OF THE CARIBBEAN FOOD CROPS SOCIETY. VOLUME VI. Sixth Annual Meeting, St. Augustine, Trinidad, July 7-13, 1968. St. Augustine, Trinidad; Caribbean Food Crops Society (1968). 160p. (CONF-680713).

Separate abstracts were prepared for two papers presented at the conference. An additional 28 papers on various methods of improving food crops were presented. (H.L.W.)

For abstracts of individual papers see: 12049 and 12344.

12344 PRESERVATION OF TROPICAL FOODSTUFFS BY IRRADIATION. Cuevas-Ruiz, Jose; Luse, R. A.; Graham, H. D. (Puerto Rico Nuclear Center, Mayaguez). pp 112-19 of Proceedings of the Caribbean Food Crops Society. Vol. VI. St. Augustine, Trinidad; Carribean Food Crops Society (1968).

See CONF-680713.

Research on radiopreservation of tropical foodstuffs is being conducted at the Puerto Rico Nuclear Center in Mayaguez with emphasis on bananas, mangoes, and plantains. Factors of preirradiation conditions, radiation dose, and postirradiation treatment which produce maximum delay of ripening and extension of shelf-life and evaluation of radiation treatment on food quality through chemical analysis for various factors are being studied. Tables are presented to show effects of dose and postirradiation storage on content of acidity, ascorbic acid, carotene, and sugar in bananas, mangoes, and plantains; shelf-life extension of irradiated mangoes as a function of sugar: acid ratio of fruits at irradiation time; and content of acidity, ascorbic acid, and sugar in irradiated and/or heat dipped mangoes. (H.L.W.)

12345 STUDIES ON THE STORAGE OF FRUITS BY IRRADIATION+ III. ON THE STORAGE OF TOMATO. Kim, Hyong Soo; Kim, Yeun Sik; Park, Kyung Tai (Radiation Research Inst. in Agriculture, Seoul). J. Nucl. Sci. (Seoul), 9: No. 1, 125-32(1969).

For the purpose of extending the storage period of fresh tomatoes, right after harvest fully ripened (red) tomatoes were treated with both CO_2 gas shock and ^{60}Co γ irradiation, stored at 20 ± 2°C (optimum temperature for tomato ripening), and appearance, color development, pH, total acidity, total carotenoids, reducing sugar, total pectin, protopectin, water soluble pectin, polygalacturonase activity were measured. CO_2 shock treatment was effective up to one week of storage but not particularly after that. With the irradiated lot, color (lycopene) development was delayed. Protopectin content decreased considerably right after irradiation and polygalacturonase activity increased right after irradiation to more than twice that of the control. (auth)

12346 STUDIES ON THE STORAGE OF IRRADIATED FRUITS. IV. ON THE STORAGE OF GRAPE AND PEACH. Kim, Kyong Soo; Kim, Yeun Sik; Park, Kyong Tai (Radiation Research Inst. in Agriculture, Seoul). J. Nucl. Sci. (Seoul); 9: No. 1, Pt. 2, 119-24(Jul 1969). (In Korean).

With the view of keeping freshness of grapes and peaches as long as possible, ripe grapes and peaches purchased from local markets were treated with CO_2 gas shock, ^{60}Co irradiation and kept at 4 ± 1°C. The appearance, color change, pH, titratable acidity, and reducing sugar were examined in the grape samples. Only appearance was examined in the treated peaches. It was possible to preserve peaches for 1 month with irradiation of 0.25 Mrad. There was no notable difference in appearance between the control and irradiated lot up to 1 month of storage, but after one and one-half months, discoloration and berry-fall off phemonenon began to occur beginning from the higher-dose irradiated lot. Prolonged preservation of grapes by irradiation seems to be impracticable. (auth)

12347 STUDIES ON THE STORAGE OF IRRADIATED FRUITS. II. ON THE STORAGE OF STRAWBERRY. Kim, Kyong Soo; Kim, Yeun Sik; Park, Kyong Tai (Radiation Research Inst. in Agriculture, Seoul). J. Nucl. Sci. (Seoul); 9: No. 1, Pt. 2, 111-18(Jul 1969). (In Korean).

In order to prolong the shelf life of strawberries, selected wholesome, fully ripened TAE-HAK 1 were treated with CO_2 gas shock for 3 hours and packaged in polyethylene film, irradiated 0.1 to 0.? Mrad using ^{60}Co γ rays, and kept at 4 ± 2°C. The changes in appearance and chemical components were determined periodically. In the CO_2 gas shock treated lot, 3 days of prolonged life was observed over the non-treated lot. Total carotenoids were not affected much by irradiation and towards the end of storage, the irradiated lot retained more total carotenoids than the control lot. Right after irradiation, reducing ascorbic acid content decreased with increased irradiation dose. At the end of the storage 0.1 and 0.2 Mrad irradiated lots retained more than twice the reducing ascorbic acid of the control lot. A dose of 0.2 Mrad is proposed as the optimum irradiation dosage in the cold storage of strawberries. It was possible to store them for 23 days. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 12450 and 12451.

12348 PLUTONIUM-DOKUMENTATION. Referate-Zeitschrift mit Anhang Transplutonium-Elemente. November 1969. Band 3, Heft 11. 202 Referate (Register-Nr. 3754-4186). (Plutonium-Documentation. Abstract Journal with Appendix on Transplutonium Elements. November 1969. Vol. 3, No. 11. 202 Abstracts (Register No. 3754-4186)). Karlsruhe, Ger.; Gesellschaft fuer Kernforschung m. b. H. (1969). 120p. (In German and English).

12349 L'HYDROGENE DANS LES METAUX. Colloque, Centre de Valduc les 27 et 28 Septembre 1967. (Hydrogen in Metals. Conference Held in Valduc, France, 27–28 September 1967). Montrouge, France; Centre d'Etudes de Bruyeres-le-Chatel (1967). 367p. 95 F.F. (CONF-670993).

Twenty-one papers were presented at the conference. A separate abstract was prepared for each of eight papers. Papers for which no abstract was prepared are concerned with embrittlement of steel, diffusion of hydrogen and deuterium in steel, stress corrosion of steel, hydrogen-charged iron, and absorption of cathodic hydrogen by iron and steel. (J.R.D.)

For abstracts of individual papers see: 12367, 12399–12404, and 12439.

Corrosion and Erosion

Refer also to abstracts 11502 and 11536.

12350 (ANL–7589) INVESTIGATION OF METALLURGICAL PROBLEMS ASSOCIATED WITH THE EBR-II FUSIBLE SEALS. EBR-II Project. Crothers, Charles C. (Argonne National Lab., Ill.). Sep 1969. Contract W-31-109-eng-38. 28p. Dep. CFSTI.

Fusible seals composed of a bismuth and tin alloy in the eutectic ratio are used in the EBR-II rotating shield plugs. Because the seal alloy is exposed to sodium in the form of vapor or aerosol from the primary tank, the plug seals were a continuing source of difficulty since the system became operable. The solubility of sodium in the seal alloy at its normal operating temperature was investigated. Intermetallic compounds of sodium with bismuth or tin usually had melting points above the operating temperature range of the fusible seals. The results of thermal analyses of a series of alloys containing bismuth and tin in the eutectic ratio and varying concentrations of sodium showed that the solubility of sodium in bismuth-tin eutectic alloy was approximately 0.35 wt % at 177°C. Apparently solids resulting from the reaction of sodium with the seal alloy did not begin to build up in the seals until this solubility was exceeded. Similar analyses were made of a series of alloys containing bismuth and tin in the eutectic ratio and approximately 1 wt % indium and varying concentrations of sodium. The solubility of sodium in the alloy containing indium was approximately 0.50 wt % at 177°C. Some associated experiments concerning dross-formation rates, alloy purification, and corrosion are reported. (auth)

12351 (BNWL–1223, pp 9.1-2) ATR WATER LOOP OPERATION AND MAINTENANCE. Hope, R. S. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The loop has operated intermittently at full power of 250 MW since 8/16/69. A total integrated power of 6,000 MWd has been achieved. Apparent radiolytic decomposition of the coolant water is causing higher O_2 pressures than anticipated. (auth)

12352 (CEA-N–1148, pp 133-66) CORROSION STUDIES. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Developments are reported for studies on: behavior of Zr alloys in water and superheated steam; corrosion behavior of steels and Fe–Cr–Ni-based alloys; corrosion problems in reprocessing plants; austenitic steel (18% Cr–10% Ni–low content C); efficiency of passive films developed at various electrode voltages; and constitution of oxide films on stainless steels (17% Cr–15% Ni–with or without Mo) in steam at 600°C. (P.C.H.)

12353 (COO–1319-79) A STUDY OF THE MECHANISM OF STRESS CORROSION CRACKING IN THE IRON–NICKEL–CHROMIUM ALLOY SYSTEM. Quarterly Report, June 17, 1968–September 16, 1968. Staehle, R. W. (Ohio State Univ., Columbus, Dept. of Metallurgical Engineering). 8 Sep 1969. Contract AT-(11-1)-1319. 38p. Dep. CFSTI.

The predictions of work from straining electrode studies have been tested by conducting stress corrosion cracking (SCC) tests at constant potential and an excellent correlation was found between these predictions and the occurrence of SCC. This correlation implies that a scoping test may be possible which would obviate the necessity for the usual large number SCC tests. Also testing of a variety of alloys having an iron base with 10–15Cr, 10–15Ni and Be, C, or Al additives shows a number of excellent possible alloys for resisting chloride SCC. Certain alloys have a virtually infinite life. (auth)

12354 (DP–1197) SILICATES AS INHIBITORS OF ALUMINUM CORROSION IN SAVANNAH RIVER REACTORS. Ondrejcin, Robert S. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Dec 1969. Contract AT(07-2)-1. 19p. Dep. CFSTI.

The corrosion rate of aluminum cladding on fuel elements in Savannah River reactors was reduced by lithium silicate. Fuel tubes were treated to form a film of lithium aluminosilicate about 1 micrometer thick on the aluminum surfaces. Corrosion of treated aluminum surfaces decreased as much as 50% after four days. After 50 to 60 days of reactor operation, treated and untreated aluminum had the same oxide thickness. Corrosion of both treated and untreated aluminum decreased 30% (on the basis of hydrogen evolution) due to the addition of a maximum of 0.5 ppM combined soluble and polymeric silica to the moderator. The addition also decreased the turbidity by reducing the concentration of hydrated aluminum oxides to <0.5 ppM, and consequently decreased the concentration of the associated fission products. (auth)

12355 (GEAP–13544) CORROSION OF STAINLESS STEEL AND DEPOSITION OF PARTICULATES IN FLOWING SODIUM SYSTEMS. TASK VI. EVALUATION OF MASS TRANSFER STATE-OF-THE-ART AND ANALYSIS OF FFTF FUEL CLADDING, PIPING, AND CLOSED LOOP MATERIAL DEGRADATION RATES. Wozadlo, G. P.; Spalaris, C. N. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Sep 1969. Contract AT(04-3)-189. 30p. Dep. CFSTI.

Corrosion allowances for sodium cooled reactor components have been summarized on the basis of data obtained in laboratory loops. These allowances take into account environmental factors affecting corrosion, except possibly radiation. No scale-up effect is expected in going from test loops to reactor systems for peak temperature regions (reactor core); since the geometry of the flow passages in these regions is simulated in loop tests. Scale-up effects in other, lower temperature regions, may be appreciable, but are probably less critical to design. Recommendations are made for additional work necessary to reduce technological risk associated with application of present data. The most urgently needed data near term are in improved precision of corrosion and properties data between 1150 and 1300°F (to reduce the design allowance for scatter in the data); measurement of rates of carbon transfer and improved means for control of carbon transfer (to limit the loss of properties of materials in core and in primary and secondary heat exchangers and to limit embrittlement of the intermediate heat exchanger (IHX), which can have consequences to plant safety); and determination of physical pattern and thermal properties of deposits of particulate materials (to provide design data for changes in pressure drop and heat transfer in IHX and in core exit regions). (auth)

12356 (GEAP–13545) INTERPRETATION OF THE ASME CODE FOR LOW-ALLOY STEELS IN BIMETALLIC SODIUM SYSTEMS. Comprelli, F. A.; Krankota, J. L. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Sep 1969. Contract AT(04-3)-189. 14p. Dep. CFSTI.

An analysis has been made of the allowable stress and strain rate criteria set out in the ASME Boiler and Pressure Vessel Code, Section VIII. Particular emphasis was directed at the application of these criteria to the design limits for low-alloy steels in bimetallic sodium systems. Design limits were estimated for several feasible interpretations of the Code for several decarburizing conditions. Comment is also offered on the advisability of a strain or strain-rate controlled design limit under these conditions. (auth)

12357 (ORNL–TM–2741) CATASTROPHIC CORROSION OF TYPE 304 STAINLESS STEEL IN A SYSTEM CIRCULATING

FUSED SODIUM FLUOROBORATE. Koger, J. W.; Litman, A. P. (Oak Ridge National Lab., Tenn.). Jan 1970. Contract W-7405-eng-26. 22p. Dep. CFSTI.

A type 304 stainless steel liquid level probe contacted fluoroborate salt ($NaBF_4$–8 mole % NaF) in an Inconel 600 pump loop at constant temperatures in the range 540 to 690°C for 192 hr. The probe exhibited heavy attack, evidenced by severe leaching of Cr, Fe, Mn, and Si from the alloy. Equivalent uniform attack was about 4 mils/day. Corrosion of the stainless steel, which is inferior to nickel-base alloys in fused fluorides, became catastrophic in this system due to dissimilar-metal effects. (auth)

12358 (WARD-3762-9) CORROSION ANALYSIS: LOW-CAPACITY PUMP. Large Sodium Pump Study, Phase II. Thomas, K. C.; Shiels, S. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). [1968]. Contract AT(30-1)-3762. 24p. Dep. CFSTI.

An evaluation was made of the effect of sodium on the integrity of the pump materials. Type 304 stainless steel was the constructional material and Stellites 1, 3, and Star J were the potential bearing materials. These materials were evaluated for use under expected pump operating conditions. Data on sodium corrosion and the effect of sodium and temperature on mechanical properties were reviewed. Corrosion losses were extended for Type 304 stainless steel. Corrosion and wear data for the bearing materials were reviewed. It was concluded that no significant materials problems should arise for an operating temperature of 900°F but that confirmatory data are required in the areas of mechanical properties in sodium, mass transfer at high velocities, and wear of bearing materials under operating conditions. (auth)

12359 THE CORROSION RESISTANCE OF NEW METALLIC MATERIALS. Takamura, Akira. Boshogu Gijutsu; 16: No. 3, 97-106(1967). (In Japanese).

A review of the physical and mechanical characteristics of Ti, Zr and Ta is presented. Data are included on the corrosion resistance of these metals in solutions of acids and also in various solutions of inorganic salts, organic alcohols and other compounds. Specific examples are examined of the behavior of Ti, Zr, and Ta under the various conditions; data are included on the production of these metals in Japan. (Referativnyi Zh.)

12360 OXIDATION KINETICS AND ITS INFLUENCE ON THE NEAR-SURFACE EFFECT OF DIFFUSION. Reimann, D. K.; Stark, J. P. (Oak Ridge National Lab., Tenn.). Acta Met.; 18: 63-70(Jan 1970).

Kinetic equations are derived which describe the effect of thermal fluctuations upon tracer oxides on the surface of diffusion specimens. The rate of metal oxide reduction by such fluctuations is shown to be consistent with observations on the near-surface effect (NSE) of diffusion. In particular, the theory is shown to explain the NSE for diffusion of ^{60}Co in Ag, ^{72}Ga in Ga, and ^{65}Zn in Cu; furthermore, experimental confirmation is found for the diffusion of ^{233}U in Au. (auth)

12361 PHYSIKALISCH-CHEMISCHE METHODEN DER KORROSIONSPRUEFUNG. Bericht Ueber die Korrosionstagung in Frankfurt/Main vom 22.–24. April 1968. (Physical-Chemical Methods of Corrosion Testing. Corrosion Conference Held in Framkfurt am Main 22–24 April 1968). Engell, Hans-Juergen (ed.). Korrosion 21. Weinheim, Ger.; Verlag Chemie GmbH (1969). 203p. (CONF-680468).

Thirty papers were presented at the conference. A separate abstract was prepared for each of six of the papers. Papers for which no abstracts were prepared are concerned with corrosion chemistry, electrochemistry, corrosion of steel, corrosion reactions, current density potential measurements, potentiostatic measurements, atmospheric corrosion, carbide precipitation in steel, equilibria in sulfate systems, electron microscope uses, surface chemistry, thermodynamic corrosion of nickel, underground corrosion, relaxation methods, ellipsometry, microanalysis using electron probes, and iron corrosion. (J.R.D.)

For abstracts of individual papers see: 12362–12366 and 12397.

12362 A STUDY OF CORROSION EFFECTS PRODUCED BY SODIUM ON METALS OF THE 4th AND 5th SUBGROUPS. Borgstedt, H. U.; Frees, G. (Kernforschungszentrum, Karlsruhe, Ger.). Korrosion; 21: 90-7(1969). (In German).

From Conference on Physical-Chemical Method of Corrosion Testing, Frankfurt-am-Main, Germany. See CONF-680468.

The action of liquid sodium on Ti, Zr, V, and Nb involves exchange of oxygen from the liquid to the solid metal phase. Because of the high energy of formation of the oxides of these metals, Na_2O contents below 10 ppM are sufficient for initiating this reaction. The oxygen is taken up by the metal matrix directly, without formation of an oxide layer; oxygen take-up is always connected with embrittlement. In many cases oxygen becomes enriched in the surface zone of the metal; in such cases several discrete layers are formed which have poor adhesion and different structure. Oxygen concentration can be assessed by microhardness measurements. (auth)

12363 PITTING AND CONTACT CORROSION IN MAGNESIUM-CANNED FUEL RODS. Thomas, M.; Weber, J. (Gebrueder Sulzer AG, Winterthur, Switzerland). Korrosion; 21: 123-8 (1969). (In German).

From Conference on Physical-Chemical Method of Corrosion Testing, Frankfurt-am-Main, Germany. See CONF-680468.

When nuclear fuel elements containing Mg, graphite and Zircaloy are stored in water there is the danger of contact corrosion of Mg in contact with graphite; in particular when chlorides are present (even in traces) there exists the danger of pitting corrosion. Only at pH values >11.5 a hydroxide layer is formed which yields a certain protection. The pitting potential in alkaline waters is shifted to more negative values with increasing chloride contents; this displacement can be prevented by inhibitors. Most efficient is the addition of sodium carbonate which gives rise to the formation of a protective hydromagnesite layer. (auth)

12364 METHODS FOR INVESTIGATION OF REACTOR MATERIALS AFTER CORROSION IN SUPERHEATED STEAM IN TEST CIRCUITS AND NUCLEAR REACTORS. Leistikow, S. Korrosion; 21: 143-8(1969). (In German).

From Conference on Physical-Chemical Method of Corrosion Testing, Frankfurt-am-Main, Germany. See CONF-680468.

If it is impossible to make gravimetric determinations one may use planimetric measurements under the optical microscope; the mean thickness of the oxide layer enables the metal losses to be calculated. A combined method involves the descaling of corroded specimens with subsequent determination of the alloy constituent concentration in the surface layer of the descaled metal; this method is suitable in particular when —as is the case during corrosion in steam under heat transfer conditions —part of the oxide is lost to the steam system. The alloy constituents are determined by the microprobe or by x-ray fluorescence. A semi-quantitative method is used for fuel elements; in this case the dimensions of the material are measured prior to use and changes are determined by optical microscopy after use. If the values thus obtained are compared with values determined in out-of-reactor experiments the influence of neutron radiation may be assessed. (auth)

12365 TWO-STAGE OXIDATION USING TRACERS OF THE OXIDIZING MEDIUM. Mrowec, S.; Werber, T. (Institut fuer Anorganische Chemie Berg- und Huettenakademie, Krakow). Korrosion; 21: 149-54(1969). (In German).

From Conference on Physical-Chemical Method of Corrosion Testing, Frankfurt-am-Main, Germany. See CONF-680468.

The mechanism of scaling can be determined using a two stage oxidation method; according to this method an isotope is added to the oxidizing medium in the second stage of the oxidation. If the isotope is radioactive, the result is evaluated by autoradiography (e.g., S, Cl, Br), otherwise mass spectroscopy is used (e.g., oxygen). Depending on the nature of the diffusion processes — diffusion of metal through the scale to the surface, or diffusion of the attacking medium through the scale to the core metal — typical concentration gradients of the isotope within the scale layer are obtained; beyond that, information is obtained concerning diffusion paths (pores, lattice defects). Experiments described include sulfidation of Ni, CuZn, and Ag. (auth)

12366 RADIOTRACER METHODS OF CORROSION TESTING. Thomas, J. G. N. (National Physical Lab., Teddington, Eng.). Korrosion; 21: 162-5(1969). (In German).

From Conference on Physical-Chemical Method of Corrosion Testing, Frankfurt-am-Main, Germany. See CONF-680468.

Radioactive isotopes provide the most sensitive methods for the determination of the uptake of material by solid surfaces. These methods fall into three groups: post-immersion counting, where the irreversible uptake is determined by counting the specimen after removal from the solution; depletion techniques where the change in concentration of the radioactive solution is measured; and immersed counting techniques. The equipment used for these measurements is described. The tracers further enable the activity distribution across larger surfaces to be determined by counting selected surface districts or by autoradiography. (auth)

12367 HYDROGEN PERMEATION AND EMBRITTLEMENT OF TITANIUM AND ITS ALLOYS. Allemand, L. R.; Fidelle, J.-P.; Rapin, M. (Centre d'Etudes de Bruyeres-le-Chatel, France). pp 242-79 of l'Hydrogene dans les Metaux. Montrouge, France; Centre d'Etudes de Bruyeres-le-Chatel (1967). (In French).

From Conference on Hydrogen in Metals, Valduc, France. See CONF-670993.

A brief review of fundamental ideas concerning titanium alloys is followed by a bibliographic survey on hydrogen absorption, diffusion and desorption, and their effects on the mechanical properties of certain alloys. Measurements on the permeability of the alloys TA5E and TA6 V to hydrogen and dueterium under pressure, at temperatures between 20 and 130°C are included. These tests showed that below 55°C the theoretical law $P = (k/e)\sqrt{p}$ does not apply at all, and that permeability is governed essentially by surface oxides. For the pressures considered these deteriorate at temperatures ranging from 55 to 93°C, above which the laws $P = k\sqrt{p}$ and especially $\log P = (k/T)$ are suitably demonstrated. The permeability is reversible as a function of temperature between 100 and 130, but not between 20 and 130°C. For the alloy TA6 V an isotopic effect $PH_2/PD_2 = 0.6$ reversed with respect to the case of steels is observed, which would mean that the state of the hydrogen and its behavior are different in these two types of alloy. Resistance tests on TA5 E spheres under high pressure gave rise to no delayed failure phenomenon at 20°C, in spite of a slight creep At 100°C on the other hand, the presence of an acicular structure and of defects due to electron beam welding caused a delayed failure preceded by a substantial permeation decrease. The cracking shows a distinctive checkered appearance and can probably be ascribed to hydride formation. (auth)

12368 THE STRESS CORROSION BEHAVIOR OF BERYLLIUM AND Be–38 PERCENT Al ALLOY IN A SALT WATER ENVIRONMENT. Moore, H. D. Jr. (Lockheed-Georgia Co., Marietta, Ga.). Sci. Advan. Mater. Process Eng. Proc.; 15: 853-9(1969).

From 15th National SAMPE Symposium and Exhibition, Los Angeles, Calif. See CONF-690436.

Studies were conducted to determine the behavior of commercially pure beryllium and Be–38% Al alloy when exposed to sustained tensile stresses and aqueous sodium chloride solution. Both materials displayed premature cracking; however, the failure mechanism for each material was observed to be different. Crack initiation in beryllium was attributed to stress-accelerated corrosion; the time required for failure to occur decreased linearly as applied tensile stresses were increased. Be–38% Al alloy failed by a stress corrosion mechanism and displayed defined stress corrosion threshold limits. (auth)

12369 THE OXIDATION OF LiF-COATED REFRACTORY METALS. Geschwind, G.; Padawer, G. (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). Sci. Advan. Mater. Process Eng. Proc.; 15: 861-73(1969).

From 15th National SAMPE Symposium and Exhibition, Los Angeles, Calif. See CONF-690436.

In the search for coatings to protect refractory metals from oxidation, fused salts have not been explored. Previous work indicated the possibility of using LiF to protect tantalum from oxidation in air. A thermogravimetric study of the oxidation of LiF-coated tantalum was carried out in air at 700 and 800°C. The presence of LiF almost completely retarded the oxidation, and a drastic change in kinetics was noted. Since quantitative analysis of the lithium distribution proved to be impossible by electron microprobe analysis, a nuclear microprobe technique was employed. These measurements involve the bombarding of the surfaces of the specimens before and after oxidation with the proton beam of the Grumman Van de Graaff accelerator. The $^{7}Li(p,\gamma)^{8}Be$ resonance at 0.441 MeV and the $^{19}F(p,\alpha\gamma)^{16}O$ resonances (doublet) at 0.874 MeV and 0.935 MeV were utilized. The intensity of characteristic gamma radiation and the energy of the incident protons furnished information whereby the density distribution of lithium and fluorine as a function of depth could be inferred. Depths as great as 25 microns could be probed with a spatial resolution of ~0.1 micron. Similar results were obtained for niobium, and only slightly less protection was afforded tungsten. (auth)

12370 DEVELOPMENT AND TESTING OF INTERMETALLIC COATED TITANIUM ALLOY GEARS. Cohen, S. H.; Delgrosso, E. J.; Mattavi, J. L.; McGivern, J. F. (Hamilton Standard, Windsor Locks, Conn.). Sci. Advan. Mater. Process Eng. Proc.; 15: 1031-42(1969).

From 15th National SAMPE Symposium and Exhibition, Los Angeles, Calif. See CONF-690436.

A program that resulted in a controllable process for forming a complex titanium-nickel intermetallic wear-resistant coating on titanium is described. The formation of this coating necessitated the development of an improved electrodeless nickel plating method, plus the determination of proper diffusion parameters and techniques to assure repeatable results. Included in the program was an experimental evaluation of the coating, employing 2.5-inch pitch diameter gears running at a pitch-line velocity of 19,600 fpm. Gear lives in excess of 10^8 cycles at representative structural unit loads demonstrated the potential weight savings of coated titanium over carburized steel. (auth)

12371 CORROSION AND ELECTROCHEMICAL BEHAVIOR OF CARBON STEELS UNDER CONDITIONS SIMILAR TO THOSE IN REACTOR OPERATION. Gerasimov, V. V.; Gromova, A. I.; Lupakov, I. S.; Morozova, I. K.; Bakulevskii, A. A.; Belous, V. N.; Kolesov, B. I. At. Energ. (USSR); 28: 13-18(Jan 1970). (In Russian).

The corrosion and electrochemical behavior of carbon steels was studied in water at 300°C with oxygen concentrations equal to 0.02 to 40 and 1000 ppM. The samples of carbon steels, irradiated in the reactor and non-irradiated samples were tested under static and dynamic conditions. The increase of oxygen concentration in water intensified corrosion of carbon steels. Irradiation reduced steel corrosion resistance during the initial test period. (auth)

Preparation and Fabrication

Refer also to abstracts 12370, 12412, and 12454.

12372 (AD–695878) FUNDAMENTALS OF METALLURGY: RARE METALS. VOLUME 1. Translation of Osnovy Metallurgii, Redkie Metally, Vol. 4, Moscow, 1967. 458p. (FTD-MT-24-160-68(Vol.1)). CFSTI.

The theory and actual production of molybdenum, tungsten, vanadium, and cobalt are described. (USGRDR)

12373 (AD–695897) FUNDAMENTALS OF METALLURGY: RARE METALS. VOLUME 2. Translation of Osnovy Metallurgii, Redkie Metally, Vol. 4, Moscow, 1967. 329p. (FTD-MT-24-160-68(Vol. 2)). CFSTI.

The theory and actual production of niobium, tantalum, zirconium, hafnium, rare earth elements, yttrium, and scandium are described. (USGRDR)

12374 (BARC–427) STUDIES ON THE PRODUCTION OF NUCLEAR GRADE ZIRCONIUM SPONGE FROM PURE ZIRCONIUM OXIDE. Babu, R. S.; Chintamani; Vijay, P. L.; Subramanyam, R. B. (Bhabha Atomic Research Centre, Bombay (India)). 1969. 19p. Dep. CFSTI (U. S. Sales Only).

The results of investigations on the production of nuclear grade zirconium sponge, starting with the high purity zirconium oxide are presented. The flowsheet includes preparation of a briquetted feed from the oxide and carbon powders, chlorination of the briquettes, purification of raw zirconium tetrachloride, magnesium and magnesium-sodium reduction of zirconium tetrachloride, vacuum distillation for isolation of zirconium sponge from by-product magnesium chloride and excess magnesium, and crushing and grading of the sponge metal. Studies were carried out to establish the influence of oxide powder characteristics on the quality of the briquettes, the optimum chlorination efficiency and chlorine utilization attainable in vertical static bed chlorinations, and to compare the quality of zirconium sponge grades obtained with raw and purified zirconium tetrachloride and in straight magnesium and magnesium–sodium bimetal reductions. (auth)

12375 CONTROLLED SOLIDIFICATION OF URANIUM PARTS BY A METHOD OF HEATING THE MOULD IN SEPARATE ZONES. Defretin, G.; de Lamer, C. Fonderie; No. 277, 155-67(Apr. 1969). (In French).

The methods usually employed to obtain controlled solidification cannot be applied in the specific case of the production of thin uranium hemispheres by vacuum melting and casting. The development of a technique enabling this problem to be solved is described. Graphite mould is divided into stages which are separately heated electrically. As soon as the part has been cast, the heating is stopped in turn in each stage, starting with the lower stage, so that the others each in turn act as a runner, until the casting has been completely solidified. This method is satisfactory and can be applied to other castings and alloys whenever sound castings and homogeneous microstructures are required. (Sum. Articles Fr. Tech. Press)

12376 REPLACEMENT HAFNIUM CONTROL RODS FOR THE BONUS REACTOR. Tolson, G. M. (Oak Ridge Gaseous Diffusion Plant, Tenn.); Davis, G. R. Nucl. Appl. Technol.; 8: 314-15(Mar 1970).

The selection of material and design, the preparation of a specification, and the manufacture of two replacement cruciform Hf control rods for the BONUS reactor are described. Difficulties in making and inspecting hafnium-to-Zircaloy welds are covered. A new type envelope gage for final dimensional inspection is also described. (auth)

12377 EFFECT OF ADDITION OF SILICON, TIN, OR VANADIUM ON THE ELINVAR PROPERTY OF NICKEL AT HIGH TEMPERATURE. Masumoto, Hakaru; Sawaya, Shohachi; Nakamura, Naoji (Research Inst. of Electric Magnetic Alloys, Sendai). J. Jap. Inst. Metals; 33: 1134-7(Oct 1969). (In Japanese).

The linear coefficient of thermal expansion, Young's modulus and its temperature coefficient, and the density were measured to investigate the effect of addition of Si, Sn, or V on the anomaly of Young's modulus, that is, the Elinvar property of nickel at high temperature. The results show that in the alloy systems, Ni–Si, Ni–Sn and Ni–V, the Elinvar property of nickel at high temperature falls gradually to room temperature along the magnetic transformation point with increasing addition of each element and also a minimum linear coefficient of thermal expansion, the so-called Invar property, appears near the composition at which the Elinvar property is revealed. (auth)

12378 ELECTRON BEAM WELDING OF STRONTIUM-FUELED CAPSULES. Gunkel, R. W.; Donnelly, R. G.; Slaughter, G. M. (Oak Ridge National Lab., Tenn.). Weld. J. (N. Y.); 48: 950-5(Dec 1969).

The electron beam welding of the Hastelloy C fuel capsules for the SNAP-21 and SNAP-23 power-generation systems showed the feasibility of using this process for satisfactorily sealing of isotopic fuel capsules. Ultrasonic inspection results showed that the SNAP-21 capsule welds easily surpassed the required 0.100 in. of sound weld metal without deterioration of the ultrasonic reference edge. The more difficult SNAP-23 capsule weld averaged 0.114 in. of sound weld metal, although a 0.080 in. minimum was found at one position. With some further refinements in welding parameters, there appears to be no reason why the desired 0.110 in. minimum penetration cannot be obtained. (auth)

12379 WELDABILITY OF TUNGSTEN BASE ALLOYS. Lessmann, G. G.; Gold, R. E. (Westinghouse Electric Co., Pittsburg). Contract NAS 3-2540. Weld. Res. (N. Y.) (Publ. in Weld. J.); 48: 528s-42s(Dec 1969).

The weldability of unalloyed tungsten and two tungsten alloys was evaluated. The alloys were W–25Re (wt %) and W–25Re–30 Mo (at. %). These were evaluated as arc cast material and for the ternary alloy also as a powder metallurgy product. The most important aspect of welding unalloyed tungsten was that it is very sensitive to thermal shock. High preheat temperatures (to 1400°F) alleviated this problem. W–25Re had improved thermal shock resistance but was shown to be basically hot tear sensitive in gas tungsten-arc welding. Preheat temperatures of 1400°F were again beneficial. The powder metallurgy W–25Re–30Mo alloy displayed excellent weldability whereas the arc cast material displayed extensive hot tearing and, hence, poor weldability. The anomalous hot tearing behavior of the arc cast W–25Re–30Mo alloy was ascribed to a very high sensitivity to oxygen contamination. The effects of post-weld annealing, joint preparation and aging for 1000 hr at temperatures to 3000°F were evaluated. The high temperature tensile strength of base metal, gas tungsten-arc welds and electron beam welds in W–25Re–30Mo was determined. (auth)

12380 BERYLLIUM-REINFORCED ALUMINUM. Fleck, J. N.; Goldstein, M. (Battelle Memorial Inst., Columbus, Ohio). Sci. Advan. Mater. Process Eng. Proc.; 15: 91-9(1969).

From 15th National SAMPE Symposium and Exhibition, Los Angeles, Calif. See CONF-690436.

Beryllium-wire-reinforced aluminum composites were fabricated by isostatic hot pressing and by explosive consolidation. A number of lay-up techniques including coated filaments, filament-foil, and dual wire were investigated. The use of coated filaments resulted in composites with excellent volumetric efficiency and very uniform microstructures. NOL ring specimens were filament wound and isostatically hot pressed. (auth)

12381 DESIGN APPLICATION OF HIGH-MODULUS FILAMENT-WOUND COMPOSITES TO AEROSPACE PROPELLANT AND PRESSURIZATION TANKS. Feldman, A.; Giguere, A. J.; Stang, D. A. (Martin Marietta Corp., Denver). Sci. Advan. Mater. Process Eng. Proc.; 15: 151-61(1969).

From 15th National SAMPE Symposium and Exhibition, Los Angeles, Calif. See CONF-690436.

Three design applications are developed comparing the performance of composite tanks, showing the potential advantages to be gained from the use of high-modulus filament-wound composites compared to tanks fabricated from conventional materials and processes. The use of high-modulus composites is justified for high-pressure applications where the permeation of the contained fluids can be effectively resisted by thin liners that are supported within the range of their elastic behavior by composite overwrap. Use of this combination of materials and fabrication techniques will provide an opportunity to design tanks that will provide better performance for the next generation of spacecraft. (auth)

12382 PREPARATION AND PROPERTIES OF CAST BERYLLIUM–ALUMINUM ALLOYS. Griffiths, L. B.; Richmond, W. J.; Krock, R. H. (P. R. Mallory and Co. Inc., Burlington, Mass.). Sci. Advan. Mater. Process Eng. Proc.; 15: 275-83(1969).

From 15th National SAMPE Symposium and Exhibition, Los Angeles, Calif. See CONF-690436.

A cast, duplex alloy of Be/Al was developed. The material contains more than 80% vol of Be and is sufficiently ductile to facilitate cold rolling up to 96% thickness reductions. Details relating to the preparative techniques together with representative mechanical properties are presented. (auth)

12383 THE FEASIBILITY OF RESISTANCE WELDING IN A HARD VACUUM. Cheever, D. L.; Howden, D. G.; Monroe, R. E. (Battelle Memorial Inst., Columbus, Ohio). Sci. Advan. Mater. Process Eng. Proc.; 15: 621-32(1969).

From 15th National SAMPE Symposium and Exhibition, Los Angeles, Calif. See CONF-690436.

Resistance spot welds were made in 2014 aluminum alloy, 304 stainless steel, and Ti-6Al-4V in air and in vacuum. Welds in titanium and, to a lesser extent, aluminum, showed a decreasing load at failure when exposed to vacuum for increased time periods prior to welding. From this research, it was concluded that resistance spot welding is an excellent candidate process for joining all three materials in space. (auth)

12384 LASER WELDING STRUCTURAL ALLOYS AND PARTS. Witt, R. H.; Kaehler, W.; Kloepper, D. (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). Sci. Advan. Mater. Process Eng. Proc.; 15: 649-79(1969).

From 15th National SAMPE Symposium and Exhibition, Los Angeles, Calif. See CONF-690436.

A high-power, pulsed laser welding system is described and its characteristics for welding structural alloys and parts is illustrated. Shielding requirements, spot size, energy output, pulse length, repetition rate, spot spacing, and filler metal requirements are presented. Applicability of the laser in comparison with other welding processes is discussed. (auth)

12385 DIFFUSION BONDED TITANIUM HONEYCOMB SANDWICH. Frazier, J. W. (Stresskin Products Co., Santa Ana, Calif.). Sci. Advan. Mater. Process Eng. Proc.; 15: 687-96(1969).

From 15th National SAMPE Symposium and Exhibition, Los Angeles, Calif. See CONF-690436.

Diffusion bonded titanium honeycomb sandwich is a newly developed highly efficient structural material. This material is obtained by a two-step process involving initial joining on production proven resistant welding equipment followed by a sub beta transus heating cycle in high vacuum. This new honeycomb sandwich material possesses excellent metallurgical integrity as evidenced by its high structural efficiency under static and fatigue testing conditions. The structural effectiveness of this material is further enhanced by its high strength to weight ratio as compared with steel and other alloy honeycomb. Significantly, diffusion bonded titanium honeycomb sandwich can now be manufactured by standard production techniques that assure a quality product at lower cost. (auth)

12386 DIFFUSION BONDING OF SUPERALLOYS. Berry, T. F.; Hoppin III, G. S. (General Electric Co., Evendale, Ohio). Sci. Advan. Mater. Process Eng. Proc.; 15: 697-714(1969).

From 15th National SAMPE Symposium and Exhibition, Los Angeles, Calif. See CONF-690436.

Diffusion bonding of two wrought nickel-base alloys has been demonstrated to be feasible. Tensile and stress-rupture strengths of joints produced were 10 to 20% lower than normally heat treated parent metal at 1200°F. Simulated hollow turbine disc of René 41 were produced using the bonding parameters developed and spun test to destruction at room temperature. Spin test failures indicated the joints to be virtually as strong as parent metal in these test pieces. (auth)

12387 ADHESIVE BONDING OF BERYLLIUM. St. Cyr, Majorie C. (McDonnell Douglas Astronautics Co., Santa Monica, Calif.). Sci. Advan. Mater. Process Eng. Proc.; 15: 719-31 (1969).

From 15th National SAMPE Symposium and Exhibition, Los Angeles, Calif. See CONF-690436.

Various methods of surface preparation of beryllium prior to bonding have been investigated. Results show that the classical sodium dichromate-sulfuric acid aluminum etch produced the highest bond strengths. The bond strengths of various types of adhesives were also evaluated. Epoxy and epoxy-modified adhesives exhibited highest promise. The use of paste type etchants reduced the safety hazard by minimizing the amount of beryllium liberated into the atmosphere. (auth)

12388 PROCESS FOR CONSOLIDATING NUCLEAR FUEL PARTICLES. Beutler, H.; Hamner, R. L.; Robbins, J. M. (to U. S. Atomic Energy Commission). U. S. Patent 3,488,409. 6 Jan 1970.

An improved process for consolidating discrete fissionable nuclear fuel particles, coated with a high density coating selected from silicon carbide or anisotropic pyrolytic carbon, into a carbon-graphite matrix nuclear fuel composite is given. An outer, high density, isotropic, pyrolytic carbon coating is deposited about the first high density coating, the coated fuel particles are placed in an elongated mold with a resin-carbon mixture, and the resulting mixture is polymerized and the fuel composite finally carbonized. (AEC)

12389 PLUTONIUM-DOKUMENTATION. Referate-Zeitschrift mit Anhang Transplutonium-Elemente. December 1969. Band 3, Heft 12. 183 Referate (Register-Nr. 4187-4738). (Plutonium-Documentation. Abstract Journal with Appendix on Transplutonium Elements. December 1969. Vol. 3, No. 12. 183 Abstracts (Register No. 4187-4738)). Karlsruhe, Ger.; Gesellschaft fuer Kernforschung m. b. H. (1969). 158p. (In German and English).

Properties Evaluations

Refer also to abstracts 12330, 12478, 12772, 12773, 12890, 12901, and 13543.

12390 (AECL-3456) REVIEW OF HIGH STRENGTH ZIRCONIUM ALLOYS. Williams, C. D. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Oct 1969. 39p. Dep. CFSTI (U. S. Sales Only). AECL $1.00.

A demand exists for a neutron-economical pressure tube alloy which can operate at a temperature in excess of 400°C. Literature covering work on zirconium alloys having strengths generally higher than the conventional zirconium-based pressure tube alloys is reviewed. Examination of this information and assessment of the composition and properties of successful high strength titanium alloys indicate that zirconium-based alloys having superior mechanical properties to those developed to date, and also having acceptable neutron capture cross-section, can be produced by conventional alloying methods. (auth)

12391 (BMI-1876) INVESTIGATION OF THE INITIATION AND EXTENT OF DUCTILE PIPE RUPTURE, PHASE II. Progress Report, October-December 1969. Eiber, Robert J.; Maxey, Willard A.; Duffy, Arthur R.; Atterbury, Thomas J. (Battelle Memorial Inst., Columbus, Ohio). Jan 1970. Contract W-7405-eng-92. 7p. Dep. CFSTI.

Activities in a program to develop methods of testing and predicting rupture in reactor cooling system pipes are reported. An experiment was conducted during the period in which a test pipe was pressured to failure. The predicted pressure at 564°F was 2250 psig and the actual failure occurred at 2400 psig. Data are included on rupture as function of time, and pressure measured as function of time. (J.R.D.)

12392 (BNWL-1171) PECT-I: A FORTRAN IV COMPUTER PROGRAM TO DETERMINE THE PLASTIC-ELASTIC CREEP AND THERMAL DEFORMATIONS IN THICK-WALLED CYLINDERS. Bard, F. E. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec 1969. Contract AT(45-1)-1830. 87p. Dep. CFSTI.

The adaptation of the PECT-I code to the problem of evaluating clad deformations in FTR fuel pins is described. A rheological model was developed, and a particular numerical procedure (for integrating with respect to space and time) was used to give a stable solution for the resulting rate equations. The numerical results show the effects of thermal and mechanical loading and different material properties on stress and strain in a thick wall cylinder. Based on these results, it is concluded that maximum cladding deformation occurs at either the midplane or hot end of the fuel pin, depending upon the material properties. (auth)

12393 (EUR-4384) DEVELOPMENT OF LOW-ALLOY TERNARY URANIUM ALLOYS (U-Nb-Cr, U-Nb-Fe, U-Nb-Ni, U-Nb-Si, U-Nb-Zr). Bastelli, M. R.; D'Amato, C.; Renzoni, R.; Saraceno, F. S.; Wilson, T. B. (Societa Nazionale Metanodotti, Milan (Italy). Laboratori Reuniti Studi e Ricerche). 3 Jul 1969. 100p. (In Italian). Dep. CFSTI (U. S. Sales Only).

Studies were made on the development of ternary uranium alloys whose irradiation behavior would, if possible, be better than that of U-1% Mo alloys. The work on the U-Nb-X ternary alloys included studies on beta-quenched and tempered U-1% Nb-0.1o-0.25% Cr alloys. Laboratory tests showed that these alloys have good structural stability at 550°C, better mechanical resistance in the cold and in the hot (550°C) state than that of traditional alloys, and better thermal cycling resistance (0 to 550°C). Creep resistance was higher when the chromium content was low (0.15% Cr). The U-1% Nb-0.15% Cr alloy is to be subjected to in-pile irradiation. (auth) (EURATOM)

12394 (RD/B/M-1482) CREEP TESTS ON A SILICON-KILLED CARBON-MANGANESE PRESSURE VESSEL STEEL. Strong, J. T. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jan 1970. 14p. Dep. CFSTI (U. S. Sales Only).

The combined results of uniaxial creep tests on a Si-killed boiler plate steel are presented. These tests were primarily undertaken to provide information for an environmental creep test on an experimental model pressure vessel, which was carried out at Berkeley Nuclear Laboratories. The results are of general interest, however, since they add to present creep data for a typical boiler plate steel (0.22% C, 0.78% Mn, and 0.2% Si). (auth) (UK)

12395 THE INOR-8 STORY. McCoy, H. E. (Oak Ridge National Lab., Tenn.). Oak Ridge Nat. Lab. Rev.; 3: No. 2, 35-48(Fall 1969).

Development of Inor-8 is reviewed. Discussions are included concerning requirements of structural materials, compositions of other alloys in the Inor series, variations of oxidation rates as a function of composition, use of Inor-8 in the MSRE, research efforts devoted to Inor-8 improvement, and properties of modified Inor-8. (J.R.D.)

12396 FATIGUE FRACTURE IN POLYCRYSTALLINE MOLYBDENUM. Beardmore, P.; Thornton, P. H. (Ford Motor Co., Dearborn, Mich.). Acta Met.; 18: 109-15(Jan 1970).

Fatigue crack growth in polycrystalline molybdenum at room temperature was examined. Crack formation occurred preferentially at grain boundaries with less frequent formation of cracks in the intense slip bands within the grains. The Stage I type of crack growth was not observed and the results indicate that the nucleation of fatigue cracks occupies the predominant part of the fatigue life over the entire life range studied. Fracture always occurred by the slow growth of a crack in a series of steps along grain boundaries approximately perpendicular to the stress axis until the crack was sufficiently large to satisfy the criterion for catastrophic cleavage. One unusual mode of crack growth was observed in which each step is believed to occur in a quasi-brittle manner. (auth)

12397 INFLUENCE OF SURFACE REACTION DIFFUSION AT HIGH TEMPERATURES ON THE FORMATION OF BRITTLE FRACTURES IN TITANIUM ALLOYS. Zwicker, U. (Univ., Erlangen, Ger.). Korrosion; 21: 133-7(1969). (In German).

From Conference on Physical-Chemical Method of Corrosion Testing, Frankfurt-am-Main, Germany. See CONF-680468.

Heat resistant titanium alloys, which in almost all cases contain aluminum as an additional element, exhibit a tendency to brittle fractures at high temperatures, whereby the optimum elongation of the samples decreases with a longer experimental time. Examinations of the alloys TiAl5Sn2.5, TiAl6V4, TiAl7Mo4 and TiAl9V3 with help of scanning electron probe microanalysis have shown that aluminum, as a consequence of reaction with the atmosphere, becomes enriched at the surface. Because of the enrichment of aluminum a super lattice of the α-solid solution is formed, which exhibits a different deformation mechanism from the α-solid solution free from super lattice. Diffusion of the aluminum occurs mainly along the grain boundaries, which also causes these to be enriched with aluminum and has an inclination to be brittle. In alloys exhibiting a polygonal grain the fractures due to brittleness are intercrystalline because of the aluminum enrichment. If the alloys are cold-formed before stress at higher temperatures the grain boundaries are destroyed and intercrystalline fracture can no longer occur. The brittle zone occurs only on the surface, and the continuation of the fracture can only take place within this area. In this case no brittleness can be observed. (auth)

12398 RELATIONS BETWEEN THE ASPECT RATIO OF FIBERS AND TENSILE STRENGTH IN TUNGSTEN-FIBER-REINFORCED ALUMINUM COMPOSITES. Miura, Ishi; Honma, Hisao; Hirano, Susumu (Tokyo Univ.). J. Jap. Inst. Metals; 33: 1171-5(Oct 1969). (In Japanese).

In order to investigate the relations between the aspect ratio of the tungsten fiber and the tensile strength in tungsten-fiber-reinforced aluminum composites, specimens were made by means of a foil metallurgy technique which has already been reported. The sandwiches of aluminum foils with the tungsten fibers were changed by rolling reduction. The used fibers were 10, 25, 50, 100 and 200 μ in diameter and their aspect ratios ranged from 15 to 35. The tensile strength of the composites increased linearly to the volume fraction of the tungsten fiber in composites, and also increased with the aspect ratio of the tungsten fibers. The tensile strength was higher than that calculated on the basis of Kelly's theory. These results imply that the elastic stress transfer in the fiber plays a more important role in discontinous fibers especially with low aspect ratio in composites. (auth)

12399 INFLUENCE OF CATHODIC LOADING CONDITIONS ON THE DELAYED FAILURE OF HIGH RESISTANCE STEELS. Weisz, M.; Petrequin, P. (CEN, Saclay, France). pp 31-45 of l'Hydrogene dans les Metaux. Montrouge, France; Centre d'Etudes de Bruyeres-le-Chatel (1967). (In French).

From Conference on Hydrogen in Metals, Valduc, France. See CONF-670993.

The main observations made on broken wires of the G2 pressure vessel prestressing cables are described. A laboratory testing method is described by which these delayed failures can be reproduced; the method involves hydrogenation under mechanical tension of test pieces removed from industrially manufactured wires. The effect of variables such as the geometry of the notch and the current density on the resistance of the steel was determined. The first results showing the preponderant effect which heat treatment of the wire exerts on the type of cracking, and the advantages of wire-drawing are summarized. (auth)

12400 HIGH PRESSURE HYDROGEN PERMEABILITY OF METALS AT ROOM AND MEDIUM TEMPERATURES. Fidelle, J.-P.; Allemand, L. R.; Rapin, M.; Hocheid, B. (Centre d'Etudes de Bruyeres-le-Chatel, France). pp 209-41 of l'Hydrogene dans les Metaux. Montrouge, France; Centre d'Etudes de Bruyeres-le-Chatel (1967). (In French).

From Conference on Hydrogen in Metals, Valduc, France. See CONF-670993.

Remarks on the motion of gases through metals and the laws which govern these processes are presented. The principles of permeability tests used in experiments with hydrogen are summarized. The studied test-pieces consisted of disks, hemispheres or spheres of different diameters and thicknesses. The thin disks, tested under pressures of 4 to 10 bars, were made of metals relatively impermeable to hydrogen: Al, Au, Be, Cd, Cu, whereas the thick samples consisted of alloys mechanically resistant to high pressures between 10 and 500 bar; they included 1 ferritic steel, 2 austenitic steels, 3 high-resistance martensitic steels, 2 light aluminum-based and 2 titanium-based alloys, sintered beryllium. Zinc was also studied under a pressure of 0.4 bar. In the temperature range considered (20 to 130°C) the conventional laws: $P = (k_1/e)$, $P = k_2 \cdot \sqrt{p}$, $P = k_3 \cdot e^{-(Q/RT)}$ hardly apply or not at all, depending on the alloys; in particular the function $\log P = (k/T)$ shows a change of slope in the temperature interval around 50 to 100°C. Since the chief purpose of the tests was to compare numerous metals under different temperature and pressure conditions, it was not possible to replace these standard laws by others. However from the differences observed it is possible to form certain hypotheses concerning the phenomena responsible. In the case of high-resistance steels and titanium alloys, certain spontaneous permeability changes may be the precursory signs of delayed failure. (auth)

12401 ROOM TEMPERATURE BEHAVIOR OF GROUP VA METALS (V, Nb, Ta) UNDER HYDROGEN EXPOSURE. Clauss, Pr. A.; Kieger, R.; Schmuck, J. (Faculte des Sciences, Strasbourg). pp 280-304 of l'Hydrogene dans les Metaux. Montrouge, France; Centre d'Etudes de Bruyeres-le-Chatel (1967). (In French).

From Conference on Hydrogen in Metals, Valduc, France. See CONF-670993.

The metals of the sub-group V-A, Vanadium, Niobium and Tantalum, are likely to present, under given conditions, an abnormal brittleness when strained in hydrogen atmosphere. This brittleness, observed at room temperature and characterized by a fall of the deformation ability, looks comparable in the three metals. It is correlated with oxygen or nitrogen, inserted in the metallic lattice. The brittleness is all the more important as the strain rate is higher: this variation allows sharp differentiation of the metal of the group V-A from iron and steels. From a lower-limited ratio of interstitial atoms, which depends on the interstitial-metal pair, the strain ability in an hydrogen atmosphere is so much the weaker as this interstitial ratio is higher. An earlier cold-working or larger diameters of the metal grains raise brittleness in hydrogen. Brittleness appearance falls with a change of the way of rupture. An interpretation of the observations is presented. (auth)

12402 STUDY OF THE HYDROGEN PENETRATION IN U-Cr-Si-Zr ALLOY. Beaumont, J. C.; Fain, E.; de Fouchier, A. (Centre d'Etudes de Bruyeres-le-Chatel, France). pp 305-12 of l'Hydrogene dans les Metaux. Montrouge, France; Centre d'Etudes de Bruyeres-le-Chatel (1967). (In French).

From Conference on Hydrogen in Metals, Valduc, France. See CONF-670993.

The duration of the induction period preceding hydrogenation of the alloy U-Cr-Si-Zr was studied at pressures between 3 and 12 bars and temperatures between 31 and 75°C, the hydrogen used containing a maximum of 10 ppM oxygen. Besides the temperature and pressure, several factors prove to have a strong influence on the induction period: the purity of the gases and the initial state of the uranium alloy (nature and thickness of the oxide film, structure of the alloy, surface preparation of the samples). In the case of a polished, degreased sample the induction periods are always reduced, and become practically nil if a little uranium hydride is placed in contact with solid uranium in the reaction vessel. The hypothesis is advanced that the induction period is very short in the case of a perfectly degassed surface. At the same time the inhibiting effect of oxygen on hydrogenation for oxygen concentrations between 100 and 5000 ppM was studied. On the basis of the results the hypothesis that the duration of the induction period in the case of a polished metal is governed by adsorption phenomena is favored. (auth)

12403 INSTALLATION FOR PRESSURIZED TRITIUM PERMEAMETRY THROUGH METALS. Broudeur, R.; Fidelle, J.-P.; Rapin, M. (Centre d'Etudes de Bruyeres-le-Chatel, France). pp 313-23 of l'Hydrogene dans les Metaux. Montrouge, France; Centre d'Etudes de Bruyeres-le-Chatel (1967). (In French).

From Conference on Hydrogen in Metals, Valduc, France. See CONF-670993.

Tritium permeates through metals in the same way as H_2 or D_2, but its radioactivity is responsible for the differences between tritium permeametry installations and those used for other H isotopes. The radioactive hazards due to tritium are increased in case of its by product, tritiated water, which is very easily absorbed by humans, and for this reason tritium gas is only delivered in low-pressure containers. It must therefore be compressed for laboratory tests, and glove boxes are used for the series of operations involved in this process such as storage of tritium on especially prepared uranium, and low-temperature molecular sieve adsorption, then pressurization by a return to the gas state in a small volume upstream from the permeation probe. On the other hand, tritium radioactivity embodies the advantage of simplifying the measurement of the amounts effused, using an ionization chamber placed downstream from the sample. (auth)

12404 INFLUENCE OF A SECOND GAS ON GASEOUS HYDROGEN ISOTOPES BEHAVIOR VERSUS METALS. Fidelle, J.-P.; Broudeur, R.; Clauss, A. (Centre d'Etudes de Bruyeres-le-Chatel, France. ENSCS, Strasbourg). pp 324-54 of l'Hydrogene dans les Metaux. Montrouge, France; Centre d'Etudes de Bruyeres-le-Chatel (1967). (In French).

From Conference on Hydrogen in Metals, Valduc, France. See CONF-670993.

The permeation of a metal by hydrogen gas and its isotopes takes place in 5 successive stages including adsorption, absorption, diffusion, and desorption, one or more of these also being involved in embrittlement processes. Three different media must be taken into account: the inlet and outlet interfaces and the metal. The action of foreign gases (GE) can therefore affect that of hydrogen during one of these 5 stages, in one of the 3 media. It is found that gases other than hydrogen may have no effect or may induce, increase, or reduce its action; being governed by their chemical nature, their state, molecular or atomic, or the medium in which their influence is exerted. When the foreign gas is an isotope of hydrogen there is always interference between the 2 isotopes: at the inlet interface, GE plays an active part and the two isotopes compete. In the metal, two situations arise according to whether GE and GP (principal gas) are different or identical. In the former case GE has a passive damping action, and must be partially displaced by GP before this latter can permeate normally. On the contrary, in the latter case the permanent permeation con-

ditions are generally reached more quickly. If GE is present in the outgoing gas phase there is competition once more between GE and GP, permeation of GP decreases while embrittlement, due to the 2 isotopes, increases. (auth)

12405 RELATION OF THE C' ELASTIC MODULUS TO STABILITY OF B.C.C. TRANSITION METALS. Fisher, E. S.; Dever, D. (Argonne National Lab., Ill.). Acta Met.; 18: 265-9(Feb 1970).

There is reasonably sound evidence that the magnitude of the elastic shear modulus C' in bcc transition metals is derived almost completely from the number of electrons per atom in the unfilled d-electron bands. For the 3d series $C' = 1.391 \times 10^{10} (e^*/a)^{3.34}$ dynes/cm^2 at 25°C for $2.15 < e^*/a < 4.0$, assuming a d^4 configuration for Cr metal. This unique relationship appears to explain the dependence of bcc phase stability on the electron concentration in transition metals and alloys. (auth)

12406 CONTINUOUS COMPILATION OF NEW REFERENCE DATA ON DIFFUSION PROCESSES IN INORGANIC SOLIDS AND THEIR MELTS. Diffus. Data; 3: 260p. 365-616(Dec 1969).

A compilation is given of reference information on mass transport in and through inorganic solids and their melts. This comprises solid and liquid substances which are solid at N. T. P., such as solid argon and ice, which are not included. The data covered include diffusion coefficient, isotope effect, thermal diffusion, electrolytic diffusion, permeation of gases, and experimental techniques. The temperature and pressure ranges over which the new data are applicable are given, as well as information on the experimental methods employed for their determination and on the purity and properties of the materials used. The author's interpretation of the data with respect to transport mechanism and transport anomalies is summarized. (J.C.W.)

12407 THE DETERMINATION OF REACTOR FUEL CLADDING TEMPERATURE BY RECORDING ^{85}Kr RELEASE DURING POST-IRRADIATION HEATING. Swanson, K. M.; Butler, J. K.; Clarke, D. (Dounreay Experimental Reactor Establishment, Caithness, Scotland). J. Nucl. Mater.; 33: 302-10(Dec 1969).

The temperature of evolution of fission product ^{85}Kr from the inside surface of reactor canning material during controlled post-irradiation heating was shown to agree to within 25°C with the irradiation temperature, estimated by more direct means. The temperature found in this way was the maximum temperature of the specimen during the last period of the irradiation where this period was of the order of the time for half the atoms in the specimen to be displaced by the high energy particle flux in the reactor. The accuracy of determining by this method a maximum temperature set by a temperature excursion in the laboratory and found by a subsequent temperature rise experiment has been shown to be ±7°C. (auth)

12408 EFFECTS OF ALLOYING ELEMENTS AND COLD WORK ON THE REDISTRIBUTION OF HYDROGEN IN ZIRCONIUM UNDER A TEMPERATURE GRADIENT. Morozumi, S.; Kitada, M.; Abe, K.; Koda, S. (Tohoku Univ., Sendai). J. Nucl. Mater.; 33: 261-70(Dec 1969).

Effects of alloying elements (beryllium, hafnium, niobium, tin, and yttrium) and of cold-swaging on the redistribution of hydrogen in zirconium with various initial hydrogen concentrations were examined after anneals under given temperature differences. For low hydrogen concentration, the alloying elements did not greatly affect the value of the heat of transport, except for the beta-martensite Zr/1 wt % Nb alloy which showed a low value. Cold-swaging enhanced the migration of hydrogen toward the cold end. The heat of transport of the worked specimens could not be calculated accurately. For high hydrogen concentration, the $\alpha/(\alpha + \delta)$ interface moved toward the cold end. As the initial concentrations were different from alloy to alloy, a normalization process was employed. The resulting comparison showed that niobium accelerated the movement of the interface. This was attributed to the fine grain size of the alloy. The movement of the interface was also enhanced by cold-swaging which probably produced many defects and elongated grain boundaries along the temperature gradient, thereby accelerating diffusion of hydrogen toward the cold end. (auth)

12409 MECHANISM OF DIFFUSION IN MONOCARBIDES OF TRANSITION METALS. Zagryazkin, V. N. Fiz. Metal. Metalloved.; 28: 292-7(Aug 1969). (In Russian).

The possible mechanisms for atom diffusion in monocarbides of titanium, zirconium, hafnium, vanadium, niobium, and tantalum were studied. It was assumed that the diffusion transition of carbon atoms takes place by using vacancies in the metallic sublattice at 2000 to 3000°C. This assumption was used to calculate the parameters of self-diffusion of metallic atoms in the monocarbides of the transition metals. (tr-auth)

12410 SELF-DIFFUSION OF CARBON IN THE CARBIDES OF IV AND V TRANSITION GROUP METALS. Andrievskii, R. A.; Klimenko, V. V.; Khromov, Yu. F. Fiz. Metal. Metalloved.; 28: 298-303(Aug 1969). (In Russian).

The self-diffusion of carbon in the carbides of Hf, Zr, Nb, and Ta at 2200 to 2800°C was studied using ^{14}C. Experimental results showed that the effects of boundary diffusion were negligible. The relationship of the parameters of self-diffusion with physicochemical properties of carbides was noted. The correlations between activation energy of self-diffusion of carbon at the melting temperature and the heat of formation of carbides were studied. The level of diffusion of mobility in carbides is discussed and the results were compared with metals. (tr-auth)

12411 SPECIFIC ENERGY OF DETERIDRATION OF CARBIDES AND THE WEAR-RESISTANCE OF ALLOYS. Popov, V. S.; Nagornyi, P. L.; Garbuzov, A. S. (Mechanical Inst., Zaporozhe, USSR). Fiz. Metal. Metalloved.; 28: 332-6(Aug 1969). (In Russian).

The energy parameters and the metallographic pictures of wear-resistant carbides during abrasive testing were studied. It was found that theoretical calculations and performance testing results were in good agreement for manganese, titanium, tungsten, vanadium, and niobium carbides. (tr-auth)

12412 APPLICATION OF ADVANCED MATERIALS TO TRUSS STRUCTURES. Davis, John G. Jr.; Rummler, Donald R. (Langley Research Center, Hampton, Va.). Sci. Advan. Mater. Process Eng. Proc.; 15: 37-57(1969).

From 15th National SAMPE Symposium and Exhibition, Los Angeles, Calif. See CONF-690436.

Lightly loaded truss-type structures applicable to unmanned spacecraft were fabricated using beryllium, Be–38% Al alloy and uniaxial boron filament reinforced epoxy tubing with adhesively bonded joints. The trusses were subjected to both dynamic and static loading conditions. Weight savings in excess of 50%, compared with an aluminum truss, have been demonstrated. (auth)

12413 CONTINUOUS CASTING AS A COMPOSITE FABRICATION PROCESS. Alexander, John A.; Davies, Lawrence G. (General Technologies Corp., Reston, Va.). Sci. Advan. Mater. Process Eng. Proc.; 15: 125-37(1969).

From 15th National SAMPE Symposium and Exhibition, Los Angeles, Calif. See CONF-690436.

The experimental effort to develop a low-cost production method for the formation of filament-reinforced metal matrix composites for structural applications is described. The capability to cast a rod composite form with 250 to 400 reinforcing filaments in three-foot lengths which exhibits a tensile strength of 189,000 psi and a modulus between 47 and 49 million psi is demonstrated. The magnesium matrix composite reinforced with 75% boron filament has a density of 0.087 lb/in.^{3} The simple process of passing an array of filaments through a metal bath in such a fashion as to accomplish wetting of the individual fibers as they enter the bath and collect them into a bundle as they are withdrawn is demonstrated to have high potential for low-cost fabrication of a useful structural form of metal matrix composite. The process is suggested as a logical choice for exploitation of the developing family of liquid metal stable filaments. The magnesium–boron continuously cast system with a strength-to-density ratio of 2.17×10^6 inches and a modulus-to-density ratio of 540×10^6 inches is recommended as a candidate for evaluation in rod, tube, I-beam, Zee or hat section form for weight-sensitive aerospace applications. (auth)

12414 UNIDIRECTIONALLY SOLIDIFIED COBALT-BASED ALLOYS FOR ELEVATED TEMPERATURE MAGNETIC APPLICATION. Kossowsky, R.; Colling, D. A. (Westinghouse Research Labs., Pittsburgh). Sci. Advan. Mater. Process Eng. Proc.; 15: 491-500(1969).

From 15th National SAMPE Symposium and Exhibition, Los Angeles, Calif. See CONF-690436.

Mechanical properties and magnetic performance were investigated in a series of CoNb eutectic based alloys. It was found that mechanical properties, such as short time compression and creep, of the directionally solidified eutectic were quite sensitive to the perfection of the lamellar structure. The results indicate also that the basic structure of the eutectic can be preserved and controlled despite the addition of iron. The addition of iron improved magnetic performance but lowered the Curie temperature. (auth)

12415 SPECIAL CORE MATERIAL TECHNOLOGIES FOR SPACE POWER ELECTRONIC APPLICATIONS. Pavlovic,

D. M. (Westinghouse Electric Corp., Lima, Ohio). Sci. Advan. Mater. Process Eng. Proc.; 15: 501-8(1969).

From 15th National SAMPE Symposium and Exhibition, Los Angeles, Calif. See CONF-690436.

Special material and process technologies, recently developed for use in space power electronic or related applications, are discussed and related to the improvements in components or devices. The technologies include: (a) structure or composition control to develop a combination of a low residual induction and a low coercive force in Fe–Al and Fe–Ni alloys for applications in pulse transformers and nonlinear reactors; (b) process control to produce a low-noise, low-loss 6.5% Si–Fe transformer core; and (c) magnetic quality control and orientation stability at high temperatures in cube-textured 3% Si–Fe (Cubex) and domain-oriented 2V-CoFe (Supermendur) tapes. (auth)

12416 ERECTABLE STRUCTURES AND MESHES FOR SPACE APPLICATIONS. Sheetz III, Harry J. (RCA Astro-Electronics Div., Princeton, N. J.). Sci. Advan. Mater. Process Eng. Proc.; 15: 509-19(1969).

From 15th National SAMPE Symposium and Exhibition, Los Angeles, Calif. See CONF-690436.

Spacecraft antennas, gravity gradient booms and radiant-energy reflectors for spacecraft which are folded or telescoped for the launch phase require new concepts of construction and deployment as their size requirements increase. New techniques in fabricating, stowing, and deploying metal booms and meshes are described. Formulas to permit analysis and design of adequate structures are given and techniques for the mounting and deployment of these structures are described. A bibliography for further reference is included. (auth)

12417 WIDE INTEGRALLY STIFFENED TITANIUM EXTRUSIONS. Stacher, George W. (Lockheed-Georgia Co., Marietta, Ga.). Sci. Advan. Mater. Process Eng. Proc.; 15: 593-600(1969).

From 15th National SAMPE Symposium and Exhibition, Los Angeles, Calif. See CONF-690436.

Wide panel titanium structural extrusions with integral stiffeners have been produced in widths of 16.1 inches and 22 inches. The long lengths involved have incorporated L-shaped stiffeners and were produced in the Ti-6Al-6V-2Sn alloy. Extrusions up to 50 feet exhibited good surfaces, straightness and dimensional tolerances. Solution heat treatment and aging cycles in conjunction with straightening by gag press, roll and creep methods at elevated temperature were accomplished. Testing indicated varying mechanical property levels commensurate with varying billet temperatures. Machining by planing with tungsten carbide cutters resulted in 30 foot panels with thicknesses as low as .037 inches. (auth)

12418 THERMAL STABILITY OF CHROMED MOLYBDENUM. Dubinin, G. N.; Mulyakaev, L. M. Metalloved. Term. Obrab. Metal.; No. 11, 35-9(1969). (In Russian).

Studies were made on the thermal stability of chromium-plated molybdenum and the methods used for plating. The highest thermal stability was achieved by the gas method using a powder mixture of 70% Cr, 25% Al_2O_3, and 5% NH_4Cl. The thermal resistance of chromium-plated molybdenum depends on the nature of the diffusion zones, which depends on the method of plating and the composition of the powder mixture. The diffusion zone, consisting of solid solution with high chromium content on the surface, exhibited high thermal stability. The relation of thermal stability to thickness of the diffusion layer and the purity of the treated surfaces was determined. (tr-auth)

Structure and Phase Studies

Refer also to abstracts 11535, 11747, and 12753.

12419 (CEA-CONF-1467) PHASE DIAGRAM OF BISMUTH UNDER HIGH PRESSURE AND LOW TEMPERATURE. Roux, C.; Andreani, M.; Rapin, M. (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). [1969]. 20p. (In French). (CONF-690908-2). Dep. CFSTI (U. S. Sales Only).

From International Conference on the Physical Properties of Solids under Pressure, Grenoble, France.

The phase diagram of bismuth was studied from 300 to 4.2°K and from 0 to 50 kbar with an equipment composed of a chamber and a piston of cylindrical form. This equipment allows the variations of resistance with pressure (temperature is left constant) or with temperature (initial pressure is blocked up) to be measured. An arrest point was found on curve representing the II → III transformation (32 kbar, 162°K). This point could be a critical one. At 77°K the transformation III → I shows a hysteresis estimated at 6 kbar: Bi III becomes superconductor towards 7°K. (France)

12420 (CEA-R-3868) INVESTIGATION OF THE GLIDE MODES OF SINGLE CRYSTALS OF BERYLLIUM. Regnier, Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec 1969. 133p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Univ. of Paris, Faculte des Sciences, Orsay, France.

The flow characteristics of single crystals of beryllium specially oriented for slip along a single plane and a single direction were investigated. The elastic limit and the strain hardening in basal glide were investigated in the temperature range (–195 to 400°C) in tension as well as in compression. Observation of the slip lines and of the dislocation configurations have also been made in addition to the mechanical tests. Prismatic slip was studied in greater detail: tensile tests were performed on specimens carefully oriented at different temperatures, strain rates, and with varying orientations of the basal and of the prism planes. Tests were also made in the microstrain range; the slip lines and the dislocation arrangements were observed in detail. The unusual variation of the elastic limit with temperature was not due to impurities but to a cross slip mechanism. A model of dislocation locking is proposed to account for the experimental results. This mechanism assumes that the $\bar{a}$ dislocations may also dissociate on the prism planes [10$\bar{1}$0]. Various possible dissociations are suggested, the most probable of which corresponds to the hexagonal close packed to body centered cubic phase transformation. The proposal can be extended to account for the relative ease of glide on the different systems in the hexagonal close packed metals. (auth)

12421 ROENTGENOGRAPHIC STUDY OF THE INTERACTION IN THE NbO–VO SYSTEM. Ivanov, A. N.; Pristavko, V. V.; Al'tshuler, A. L. (Moscow Steel and Alloys Inst.). Izv. Akad. Nauk SSSR, Neorg. Mater.; 5: 2224-6(Dec 1969). (In Russian).

The similarity of the electron structure of the metals of the fourth and fifth groups of the periodic system and the small differences in their lattice constants cause the unlimited mutual solubility of many of their oxides and carbides; such a behavior is expected also in the system of the monoxides of V and Nb. However, the specific structure of NbO complicated the situation: the vacancy concentration of the two sublattices of NbO was 25% against 15% in the case of VO. The system was studied by firing pressed compacts containing varying amounts of NbO and VO in a vacuum of 10^{-4} mm of Hg to 1600°C for 10 hours and examining the phases. The specimens containing 78.8 to 40 mole % of VO had a two-phase structure; the other compositions exhibited a single phase. X-ray spectroscopic study revealed that in the two-phase region the NbO content was constant in each of the phases within an error of 5%. Interaction in the solid state resulted in two solid solutions; the VO-based solution contained up to 18.5 mole % of NbO, while the NbO-based one contained 29.5 mole % of VO. Phase equilibrium at 1500°C showed that the mutual solubility of the components remained unchanged. (TTT)

12422 POLARIZED LIGHT AND DARK FIELD ILLUMINATION IN QUANTITATIVE STRUCTURE ANALYSIS. Nazare, Silvestre; Ondracek, Gerhard (Kernforschungszentrum, Karlsruhe, Ger.). Prakt. Metallog.; 6: 742-6(Dec 1969). (In German and English).

Investigations of reaction kinetics by means of the Quantimet are used as an example of the combined use of different microscopic methods which can lead to useful results. Measurements carried out include evaluation of an intermetallic uranium aluminide in polarized light, determination of porosity using dark field illumination, and determination of both dispersed phases in the structure. This combination gives the information necessary for the determination of the reaction rate which could not be obtained using the usual image analysis with bright field illumination. (auth)

12423 METALLOGRAPHIC PRESENTATION OF PHASES IN EQUILIBRIUM DIAGRAMS. Seifahrt, Horst; Kriebel, Helga; Knotek, Otto (Versuchsanstalt der Castolin Schweissmaterial AG, Lausanne, Switzerland). Prakt. Metallog.; 6: 698-705(Dec 1969). (In German and English).

In a study of the quaternary system C–Co–Cr–W the melted, homogenized alloys were metallographically evaluated and pictures of the structures systematically arranged in sections of equal concentration through the isothermal tetrahedron. After suitable etching of the specimens the individually occurring phases can be differentiated with some certainty and boundaries can be set to the phases. The results of x-ray fine structure analysis must be used to identify the structural constituents. The metallographic investigations are often more accurate for the determination of

the phase boundaries because traces of phases can be seen which elude the x-ray method. Clearest of all is the position of the eutectic valleys. (auth)

12424 METALLOGRAPHY OF ZIRCONIUM AND ZIRCONIUM ALLOYS. Boelsing, Renate; Dressler, Gert (Metallgesellschaft AG, Frankfurt am Main). Prakt. Metallog.; 6: 706-10 (Dec 1969). (In German and English).

The metallographic (grinding, polishing, etching) and optical microscope techniques for the production of polished specimens of zirconium and zirconium alloys are described. The identification of the structural constituents of such alloys is illustrated by examples. (auth)

12425 DISLOCATION DYNAMICS IN NIOBIUM SINGLE CRYSTALS. Evans, K. R. (Shell Development Co., Emeryville, Calif.); Schwenk, E. B. Acta Met.; 18: 1-8(Jan 1970).

The dislocation velocity–stress exponent, m*, has been calculated for niobium single crystals from strain-rate sensitivity measurements of the effective flow stress, τ^*. m* is found to be independent of strain for temperatures at and above 158°K, while at 77 and 113°K m* increases markedly with strain. The increase in m* with strain at low temperatures is attributed to an increase in the mobile dislocation density with strain-rate. Evaluation of the temperature dependence of τ^* at various strains indicates that the mobile dislocation density at a specific, imposed strain-rate increases with strain at 77 and 113°K. m* at a strain of 0.05 is found to increase from 5.5 at 273 to 27 at 77°K. (auth)

12426 CRYSTAL STRUCTURES OF TRANSITION PHASES FORMED IN U/16.60 AT. PERCENT Nb/5.64 AT. PERCENT Zr ALLOYS. Yakel, Harry L. (Oak Ridge National Lab., Tenn.). J. Nucl. Mater.; 33: 286-95(Dec 1969).

Single-crystal x-ray diffraction studies of γ-quenched and aged alloys of uranium with 16.60 at. % (7.5 wt %) niobium and 5.64 at. % (2.5 wt %) zirconium revealed two metastable transition phases whose structures were derived from small atom displacements from some of the sites occupied in the A2 γ structure. The phases appeared to be identical with those previously reported as having chemically ordered structures in γ-quenched uranium-molybdenum and uranium-niobium alloys. The first transition structure, γ^s, was formed on γ quenching; it was cubic, space group $I\bar{4}3m$, with a unit cell parameter about twice that of the γ phase. It may be formally described as eight unit cells of the γ structure in which the body-centered atoms have moved in correlated ⟨100⟩ directions. On aging at 150 or 350°C, these movements are further correlated along a particular [001] direction, producing the second transition structure, γ^0; it is tetragonal, space group P4/nmm, with an atom arrangement similar to that reported for β-neptunium. No evidence was found to suggest significant chemical order in either transition structure. (auth)

12427 A MICROANALYSIS INVESTIGATION OF AN EMBRITTLED STAINLESS STEEL SHEATH. Ranzetta, G. V. T. (United Kingdom Atomic Energy Authority, Aldermaston, Eng.); Evans, J. H. J. Nucl. Mater.; 33: 315-17(Dec 1969).

An embrittled stainless steel thermocouple sheath was examined by electron-probe microanalysis in order to identify the foreign elements responsible for the formation of the embrittled phase. The carbon and nitrogen content was found to vary across the embrittled phase. It appeared that the nitrogen in the steel forced the carbon out of solution, causing this element to concentrate at the interface. The source of nitrogen was not located. (G.M.C.)

12428 MECHANICAL INSTABILITIES IN THE B.C.C. LATTICE AND THE BETA TO OMEGA PHASE TRANSFORMATION. De Fontaine, D. (Univ. of California, Los Angeles). Acta Met.; 18: 275-9(Feb 1970).

The beta to omega phase transformation in certain titanium and zirconium alloys can be accomplished formally by subjecting the bcc lattice to a transverse sinusoidal displacement wave of wave vector $\frac{1}{3}$ ⟨112⟩, crystallographically equivalent to a $\frac{2}{3}$ ⟨111⟩ longitudinal wave. The instability of this particular mode corresponds to negative eigenvalues of the dynamical matrix of the average bcc crystal in the vicinity of the point $\frac{1}{3}$ ⟨112⟩ in the first Brillouin zone. By mapping out the regions of negative eigenvalues, one can reproduce the essential features of electron diffraction patterns obtained from as-quenched Zr–Ti alloys. The positions and shapes of the ω reflections and the corresponding diffuse intensity are predicted correctly. (auth)

12429 EFFECTS OF REFRACTORY OXIDES ON THE RECRYSTALLIZATION OF NIOBIUM ALLOYS. Pridantsev, M. V.; Grigorovich, V. K.; Sheftel, E. N. (Inst. of Metallurgy, Moscow). Metalloved. Term. Obrab. Metal.; No. 11, 4-9(1969). (In Russian).

Studies were made on the stability of niobium alloys during plastic deformation in relation to increase of the oxide phase. The dispersed oxide phase retarded the development of the recrystallization process. At certain compositions, the initial temperature of the recrystallization increased by 175 to 200°C. The increase in temperature of recrystallization was dependent on the quantity of the oxidation phase. The more thermal resistant phase of HfO_2 sharply retarded the grain growth and secondary recrystallization of niobium in comparison with ZrO_2. (tr-auth)

12430 EFFECTS OF ALLOYING ELEMENTS ON BORATED REFRACTORY METALS. Samsonov, G. V.; Zhunkovskii, G. L. (Inst. of Problems in Material Studies, Moscow). Metalloved. Term. Obrab. Metal.; No. 11, 32-5(1969). (In Russian).

Studies were made on the diffusion mobility of boron in the V–Ti, V–Cr, V–Mo, and V–Nb alloys. It was found that a small addition of V increased significantly the thickness of the boride layer on the alloys studied and slowed down the diffusion of boron at higher concentrations. The addition of vanadium to niobium or titanium affected only the phase composition and the structure of the diffusion zones. (tr-auth)

12431 CONSTRUCTION REGULARITIES IN PHASE DIAGRAMS OF THE SYSTEMS OF TRANSITIONAL METAL GROUPS III–VI. Upadkhaya, G. Sh.; Samsonov, G. V. (Kiev Polytechnical Inst.). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 3, 114-20(1969). (In Russian).

Phase diagrams are given for the alloys: Y–Ti, Y–Zr, Y–Hf, Y–V, Y–Nb, Y–Ta, Y–Cr, Y–Mo, Y–W, Er–Ti, Cd–Ti, Y–Cd, Ti–Zr, Zr–Hf, Ti–Hf, V–Nb, Nb–Ta, V–Ta, Cr–Mo, Mo–W, and Cr–W. (D.H.M.)

Radiation Effects

Refer also to abstracts 11861 and 13525.

12432 (AD-696057) BEHAVIOR OF MECHANICAL PROPERTIES IN NEUTRON IRRADIATED 12Ni-5Cr-3Mo MARAGING STEEL PLATE AND COMPANION WELD METALS. Gray, R. A. Jr.; Hawthorne, J. R. (Naval Research Lab., Washington, D. C.). 2 Oct 1969. 20p. (NRL-6945). CFSTI.

Changes of Charpy-V notch ductility and tensile strength in neutron-irradiated 12Ni-5Cr-3Mo maraging steel were evaluated following low (less than 250°F) and elevated (550 to 740°F) temperature exposure. The study was performed with six heats of 1-in.-thick plate material aged at 900°F for 2 and 20 hr to nominal yield strengths of 160 and 180 ksi, respectively. The long-term thermal stability of both heat-treatment conditions was investigated for the conditions of irradiation. The less than 250°F and 550°F irradiation performance of matching (15-5-3) and mismatching (17Ni-2Co-3Mo) TIG weld deposits maraged to 180 ksi yield strength was also assessed in this study. Changes in the general properties of the 12-5-3 maraging steel plate and companion weld metals were found to be rather small with less than 250°F exposures, indicating good resistance to neutron-induced embrittlement. However, a marked deterioration of notch-ductility properties with long-term exposure at elevated temperature was revealed and traced to a nonnuclear thermal instability. The observed instability is believed to be a continuation of aging processes at temperatures well below the initial maraging temperature. Extended time-at-temperature treatments indicate that service above 550°F may produce sufficient changes in properties for failure by low-energy tear. Aging treatments of 1900 to 3300 hours' duration increased the yield and tensile strengths of the 12-5-3 alloy by as much as 52.0 and 53.3 ksi, respectively, while not altering appreciably the percentage of elongation and the reduction in area. (auth) (USGRDR)

12433 (ANL-7588) A MODEL FOR VOID FORMATION IN METALS IRRADIATED IN A FAST-NEUTRON ENVIRONMENT. Harkness, Samuel D.; Li, Che-Yu (Argonne National Lab., Ill.). Aug 1969. Contract W-31-109-eng-38. 29p. Dep. CFSTI.

Experimental observations of void formation in Type 304 stainless steel irradiated with fast neutrons are presented. The irradiated microstructure was characterized by a homogeneous distribution of both polyhedral voids and Frank dislocation loops. The number densities for each species were about $10^{15}/cm^3$; the defects were up to several hundred angstroms in size. Neither defect type, however, formed at grain boundaries. The temperature dependence of void formation is discussed from observations of three samples that received a fluence of 2×10^{22} n/cm² at 375, 460, and 600°C. No observable voids formed at 600°C, whereas

void formation was greater at 460°C than at 375°C. A model to explain these observations was developed, based on classical nucleation and growth theory. The results from the model were then incorporated into a Johnson-Mehl expression to determine a theoretical temperature dependence for void formation. This approach gave good agreement with experimental results. The presence of helium atoms is suggested as an important factor in void nucleation in stainless steel. The gas atoms may stabilize the voids, which, in austenitic stainless steel, are a higher energy form than planar defects. (auth)

12434 (BNWL-1223, pp 4.1-107) IRRADIATION DAMAGE TO REACTOR METALS. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Summaries are presented on the operation of irradiation facilities, thermomechanical improvements of stainless steel, radioinduced voids in nickel, investigations of radiation effects on fracture of heavy section steel pressure vessels, radiation effects on tensile properties of Zircaloy-2, radioinduced swelling and tensile damage to Type 316 stainless steel, mechanical testing of fuel pin cladding, radiation effects on tensile properties of Type 304 stainless steel, and work on evaluation of aging effects in Types 304 and 316 stainless steel. (J.R.D.)

12435 (BNWL-1223, pp 5.1-40) FAST REACTOR DOSIMETRY AND DAMAGE ANALYSIS. Nightingale, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

As a result of the EBR-II Run 31F dosimetry test, reaction rates for ~20 fission and nonfission flux monitors are now available for r and z coordinates (in cm) from (0,0) to (33,60). Multiple foil and time-of-flight derived neutron flux-spectra and foil reaction spectral averaged cross sections have been compared for a core center and surface location for a bare ^{235}U assembly. The good agreement in the results found for the core center position establishes increased confidence in current microscopic cross section data and multiple foil results. A preliminary form of a damage function for 304 SS has been obtained for the irradiation induced change in total elongation. The computer simulation of metal lattices shows ordering of a grain boundary by carbon atoms. In a cell containing 1275 iron atoms, one carbon atom added to the misfit region of the grain boundary essentially caused complete local ordering of the structure. It is apparent that a small concentration of carbon can drastically alter the strength of iron-based metals and alloys. Insight into precipitation mechanisms may be gained from the qualitative accommodation and migration data. (auth)

12436 (CEA-R-3273) STUDY OF THE EVOLUTION OF HELIUM PRODUCED BY NUCLEAR REACTIONS IN BeO. Bareau, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct 1969. 79p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Univ. of Paris, France.

An in-pile investigation was conducted of He formed by (n,2n) and (n,α) reactions and released from irradiated BeO, at 1,000 to 1,350°C. The results show that, for an instantaneous neutron fast flux of 10^{13} n cm^{-2} sec^{-1}, equilibrium is established after several days, which represents a release which is lower than 20 per cent of the quantity of He which is theoretically calculated from the neutron cross sections for nuclear reactions, and from the analytical form of the neutron fast flux. The validity of the values of calculated helium and the gas chromatographic analytical method are also verified by dissolution of the BeO pellets in cryolite. A new fast neutron flux measuring method may be so defined. The discussion of the experimental results allows the conclusion that the processes of He release are characterized by two phenomena: the first one which controls the release of He atoms out of the solid and the second which reveals capture processes, connected to the irradiation and probably due to the vacancies induced in the lattice. (auth)

12437 (CEA-R-3857) A STUDY OF POINT DEFECTS CREATED BY ELECTRON IRRADIATION OF DILUTE IRON-CARBON ALLOYS. Leveque, Jean-Luc (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Oct 1969. 52p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis.

Resistivity and magnetic after effect (m.a.e.) measurements are used to study the effects of carbon atoms on the annealing process of point defects created by electron irradiation (3 MeV) at 20°K. The presence of the carbon atoms has a strong effect on the recovery substage I_E and stage III. For the former, the carbon impurity traps the freely migrating iron interstitial. For the latter the effect is interpreted as being due to formation during annealing, of a carbon vacancy pair. A pronounced m.a.e. band is attributed to the reorientation of this carbon vacancy complex. These results are coherent with the interpretation of low temperature migrating free interstitials. (auth)

12438 STUDY OF RADIATION DAMAGE IN TUNGSTEN. I. Jeannotte, D. (IBM Components Div., East Fishkill, N. Y.); Galligan, J. M. Acta Met.; 18: 71-9(Jan 1970).

Direct measurements of the kinetics of vacancy removal in neutron irradiated tungsten are presented. These measurements show that vacancies are mobile in stage IV recovery of this material. A comparison of this experiment with the self diffusion measurements of Andelin, Knight and Kahn and the quenching measurements of Schultz, shows that the activation energy for self diffusion is consistent with a vacancy mechanism. (auth)

12439 EMBRITTLEMENT OF A STEEL ATTRIBUTED TO THE ACTION OF RADIOLYTIC HYDROGEN. Kamoun, G. (Laboratoire Central Sud Aviation, Courbevoie, France). pp 20-4 of l'Hydrogene dans les Metaux. Montrouge, France; Centre d'Etudes de Bruyeres-le-Chatel (1967). (In French).

From Conference on Hydrogen in Metals, Valduc, France. See CONF-670993.

In the reactor CELESTIN, high-resistance stainless steel springs are designed to operate under radiation in the presence of heavy water. Subjected to irradiation tests in an experimental reactor (TRITON) these elements reacted catastrophically (multiple rupture in a few days). The study which followed showed the influence of the radiolysis hydrogen in the phenomenon. (auth)

12440 FAST-NEUTRON IRRADIATION EFFECTS ON DISLOCATION STRUCTURES IN IRON STRAINED AT AMBIENT TEMPERATURE. Bryner, J.S.; Chow, J. G. Y. (Brookhaven National Lab., Upton, N. Y.). Acta Met.; 18: 191-200(Feb 1970).

Specimens for electron-transmission microscopy were prepared from tensile test bars of Ferrovac E iron which was strained at ambient temperature after irradiation with fast neutrons to fluences of 2×10^{18}, 1×10^{19}, and 2×10^{20} nvt (E > 1.45 MeV). Dislocation structures were compared with those in similar unirradiated specimens, and correlated with the true stress-strain curves obtained from the test bars. In irradiated specimens low strains produced straighter, less tangled dislocations, and higher strains produced a higher concentration of debris than in unirradiated specimens. At similar strain levels, dislocation concentrations, structures, and distributions in irradiated specimens were similar to those in unirradiated specimens. Dislocation channeling did not occur in irradiated specimens. It is concluded that effects of fast-neutron irradiation on the flow stress and strain-hardening rate of Ferrovac E iron at ambient temperature are not caused by effects of irradiation on the dislocation structures resulting from strain. The effect of strain dislocations on the flow stress is less in the irradiated case because their effect in decreasing the distance between obstacles to dislocation motion is reduced by the high concentration of radiation defect obstacles. (auth)

12441 INFLUENCE OF COLD WORKING AND RECRYSTALLIZATION ON THE RADIATION INDUCED HIGH TEMPERATURE EMBRITTLEMENT OF AUSTENITIC STEELS. Boehm, H.; Hauck, H.; Hess, G. (Kernforschungszentrum, Karlsruhe, Ger.). J. Nucl. Mater.; 33: 347-51(Dec 1969).

The influence of the cold working direction and recrystallization on the radioinduced high-temperature embrittlement of austenitic stainless steel rods was investigated. The specimens were irradiated to a thermal neutron dose of 3×10^{20} n/cm^2. Considerable differences in the ductility perpendicular and parallel to the direction of rolling were found. The embrittlement of specimens recrystallized after irradiation was less than that of specimens recrystallized before. (G.M.C.)

12442 POSTIRRADIATION CREEP-RUPTURE PROPERTIES OF AUSTENITIC STAINLESS STEEL AND NICKEL-BASE ALLOYS. Boehm, H.; Hauck, H.; Leo, W.; Wassilew, C. (Kernforschungszentrum, Karlsruhe, Ger.). J. Nucl. Mater.; 33: 343-6 (Dec 1969).

The stress-rupture properties of unirradiated and irradiated Inconel 625, Inconel 718, and austenitic stainless steel were studied. The samples were irradiated to a fluence of 0.81×10^{22} n/cm^2 (>1 MeV) at a temperature <100°C. The influence of radiation on the minimum creep-rate of austenitic stainless steel was also determined. (G.M.C.)

12443 RECOVERY OF DAMAGE IN NEUTRON IRRADIATED W/25 WT. PERCENT Re. Keys, L. K.; Smith, J. P.; Moteff, J. (General Electric Co., Cincinnati). Contract AT(40-1)-2847. J. Nucl. Mater.; 33: 337-9(Dec 1969).

The effects of rhenium concentration on the recovery of fast neutron damage in tungsten were studied by examining the recovery in a polycrystalline W-25 wt % Re rod. The rod was irra-

diated to a fast neutron fluence of 1.1×10^{19} n/cm^2 and a thermal neutron fluence of 9.3×10^{19} n/cm^2 and was then annealed at 70 to 1900°C. It was found that a high rhenium concentration led to a shift of the major defect recovery temperature regions to lower temperatures. (G.M.C.)

12444 DEFORMATION TWINNING IN NEUTRON-IRRADIATED VANADIUM. Smolik, G. R.; Chen, C. W. (Ames Lab., Iowa). J. Nucl. Mater.; 33: 320-3(Dec 1969).

The effects of neutron irradiation and subsequent annealing on the twinning behavior of vanadium were investigated. The specimens were irradiated with an integrated neutron flux of 1.6×10^{18} nvt (E > 1 MeV) for 10 days and annealed for 1 hr at 170 to 298°K. The fast neutron irradiations at 83°K led to drastic reduction of twinning in tensile tests at liquid nitrogen temperature and the recovery of twinning necessitated an anneal above a critical temperature. (G.M.C.)

12445 VOIDS IN IRRADIATED TUNGSTEN AND MOLYBDENUM. Rau, R. C.; Ladd, R. L.; Moteff, J. (General Electric Co., Cincinnati). Contract AT(40-1)-2487. J. Nucl. Mater.; 33: 324-7(Dec 1969).

The occurrence of radioinduced voids in bcc tungsten and molybdenum was investigated. Cylindrical creep-rupture bars of powder metallurgy tungsten and vacuum arc-cast molybdenum were irradiated to fast neutron fluences of 1.3 to 1.8×10^{20} n/cm^2. Tungsten was irradiated at 1000 and 1300°C, while molybdenum was irradiated at 700 and 1000°C. The void size and volume fraction in both metals increased with increasing temperature, but irradiation at similar homologous temperatures did not produce similar void populations in the two metals. (G.M.C.)

12446 OBSERVATION OF SHIFTED ATOMS AND THEIR COMPLEXES IN IRRADIATED METALLIC SPECIMENS. Suvorov, A. L.; Kukavadze, G. M. Fiz. Metal. Metalloved.; 28: 238-45(Aug 1969). (In Russian).

Studies were made of the appearance of shifted atoms in tungsten specimens which were subjected to bombardment by deuterons at 5, 10, and 12 MeV. It was found that the ionic images of irradiated specimens at 78°K permitted direct observation of individual shifted atoms and evaluation of their concentration. Crystallographic distribution of observed defects was accomplished by cooling the specimens to temperatures below 21°K. (tr-auth)

12447 ANNEALING OF RADIATION DEFECTS IN MONOCRYSTALS OF COPPER. Gruzin, P. L.; Zharov, Yu. D.; Machurin, E. S. (Central Scientific-Research Inst. of Ferrous Metallurgy, Moscow). Fiz. Metal. Metalloved.; 28: 251-5(Aug 1969). (In Russian).

The interaction of dislocations with radioinduced point defects was studied by internal friction methods in monocrystals of Cu, which were induced by 2 to 2.5 MeV electrons. The values of energies of activation of migration and point defects at various stages were 0.68 and 0.9 eV. It was found that under the action of the variable elastic tensions the redistribution of point defects on dislocations occurred. The possible mechanism of placement of dislocations by radiation defects is discussed. (tr-auth)

12448 IRRADIATION CREEP IN THE DOURNREAY FAST REACTOR. Mosedale, D.; Lewthwaite, G. W.; Leet, G. O.; Sloss, W. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). Nature (London); 224: 1301-2(27 Dec 1969).

Some measurements on Nimonic alloys, stainless steels, Mo, and Ni, in the form of helical springs, are described. The specimens were immersed in Na and creep deflections were estimated from pre- and post-irradiation x-radiographs of the rigs. Associated laboratory control tests are also described. Times of reactor exposure varied between 945 and 2,140 hr. It was found that the pure metals showed much more creep than the alloys; Ni showed the greatest creep. The results for some comparative thermal neutron irradiations in the DMTR are also given. The irradiation creep of Nimonic 80A and DFR was considerably less than in DMTR, while that of Nimonic PE 16 was slightly less. With regard to annealed 316 SS the form of the creep apparently differed in the two reactors; whereas with thermal irradiation the creep quickly saturated, a continuing component appeared in the fast reactor experiments. A comprehensive explanation of the results must take account of the temperature difference (about 150°C) between the thermal and fast irradiations, but no clear trend was obvious; the steady state and transient components of creep, defined in terms of fluence dependence, appeared to depend differently on temperature in different materials. (UK)

12449 PHYSICAL PROPERTIES OF NEUTRON IRRADIATED MOLYBDENUM. Pedchenko, K. S.; Karasev, V. S. (Inst. of Physics, Kiev). Ukr. Fiz. Zh.; 19: 1554-6(1969). (In Russian).

Electric resistance, emf, lattice parameters, and energy release during defect annealing were studied using preliminary annealed specimens of (99.9%) Mo polycrystals at 1200°C and irradiated by various doses of fast neutrons in the WWR-M reactor at 60 to 65°C. Data are given on the physical characteristics of the specimens as functions of the radiation dose and annealing temperature. (R.V.J.)

Ceramics and Cermets

12450 (BNWL-1223) REACTOR FUELS AND MATERIALS DEVELOPMENT PROGRAMS FOR FUELS AND MATERIALS BRANCH. Quarterly Progress Report, July-September 1969. Sheely, W. F. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov 1969. Contract AT(45-1)-1830. 251p. Dep. CFSTI.

Reactor fuels development progress is reported in eight sections. A separate abstract was prepared for each section. (J.R.D.)

For abstracts of individual sections see: 11747, 12351, 12434, 12435, 12462, and 12483–12485.

12451 MATERIALS AND PROCESSES FOR THE 70'S. 15th National SAMPE Symposium and Exhibition, April 29, 30, and May 1, 1969, Los Angeles, California. Science of Advanced Materials and Process Engineerings Proceedings. Volume 15. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1969). 1160p. (CONF-690436).

Eighty-eight papers were presented at the symposium. A separate abstract was prepared for each of twenty-nine papers. Papers for which no abstracts were prepared are concerned with energy dissipating materials, polyimide laminates, Al structures, synthetic foams, silicon nitride fibers, graphite composites, properties of 55-Nitinol alloy, ceramics, polymers, space simulation, silicone rubbers, fluorocarbons, seals, clean rooms, welding, adhesives, urethanes, aircraft materials, solid lubricants, and processing materials in space. (J.R.D.)

For abstracts of individual papers see: 11750, 12368–12370, 12380–12387, 12412–12417, 12456, 12457, 12472–12478, 12496, and 12497.

Preparation and Fabrication

Refer also to abstracts 11515, 12381, and 12389.

12452 (BAW-3714-15) GEL-ADDITION PROCESS CHEMICAL STUDIES. Quarterly Progress Report No. 13, August-October 1969. Carlson, R. V. (comp.) (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.). Dec 1969. Contract AT(30-1)-3714. 42p. Dep. CFSTI.

The development of a sol-gel process and related processes for preparing (U, Pu)O_2 fast reactor fuels has continued. About 4.3 kg of ceramic-grade powder containing 20% PuO_2 in fully enriched UO_2 were prepared by continuous coprecipitation for irradiation in the EBR-II. The construction and cold checkout of a unit-operation-scale system for forming (U, Pu)O_2 sol-gel microspheres were completed. All pellet, vipac, and sphere-pac fuel pins required for the FY-1970 irradiation program in the BAWTR were fabricated and are awaiting end-cap welding. The pellets containing 20% PuO_2 in fully enriched UO_2 were fabricated as required for the initial EBR-II irradiation test. (auth)

12453 (BNWL-1241) SINTER: A PROGRAM FOR CALCULATING RADIAL TEMPERATURE DISTRIBUTIONS IN OXIDE FUEL PINS UNDERGOING SINTERING. Merckx, K. R.; Fox, G. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan 1970. Contract AT(45-1)-1830. 19p. Dep. CFSTI.

SINTER is a program for calculating the steady state radial temperature distribution within the fuel material of cylindrical fuel rods. The method uses the integral of the thermal conductivity over the temperature range which includes the temperature dependence for thermal conductivity. The fuel temperature distribution includes the effect of restructuring or sintering of the fuel material. The radius of the central void caused by such sintering is also calculated. The theoretical basis of the procedure for calculating the temperature distributions and the geometrical changes is reviewed. (auth)

12454 (KFK-1023) FABRICATION OF CERAMIC MATERIALS BY MELTING IN AN OVERPRESSURE ELECTRIC ARC FURNACE. Thuemmler, F.; Wedemeyer, H.; Politis, C. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer

Material- und Festkoerperforschung). Aug 1969. 14p. Dep. CFSTI (U. S. Sales Only).

To melt ceramic materials of very high purity an arc furnace was developed in which it is possible to work under an overpressure of up to 20 atm. The installation is equipped with a mold carrier for button specimens and interchangeable crucibles for larger charges and can be used with a permanent electrode or a consumable electrode. The power supply includes a rectifier which at no-load voltage of 75 V gives a maximum melting current of 2250 A, and of 1120 A at 150 V. The range of application of the over-pressure arc furnace ranged from the preparation of particularly pure laboratory specimens to the preparation of massive fused ceramic bodies. By working under high inert gas pressure, it was possible to produce melts of mixtures of materials of different melting points such as UO_2 and Cu. Under high nitrogen pressure it was possible to directly convert metals with higher melting points into nitrides, even those with a high decomposition pressure such as UN. The coarse grained fused bodies, produced by the consumable electrode technique, were suitable for the production of powders for vibration compacting of fuel rods. Compounds such as UN, U(N, C) and U(O, C), which are of interest in the nuclear technology for future nuclear fuels, were successfully melted using this technique. If the distance between the electrode and the melt was kept constant when melting uranium electrodes under an overpressure of 15 to 20 atm of N_2, the UN produced contained no free uranium; small concentrations of a higher uranium nitride could be removed by additional annealing. Very pure U(N, C) was obtained by melting together massive pieces of UN and UC with a permanent electrode under an overpressure of 3 to 5 atm of N_2. Melting UO_2 and UC with a carbon electrode under an overpressure of 3 to 5 atm of argon, gave massive U(O, C) with uranium metal impurities at the grain boundaries. By adding appropriate quantities of carbon to the melt charge, the formation of uranium metal was avoided. X-ray and metallographic investigations of specimens of $DyNi_2$, $DyAl_2$, $HoFe_2$, and $HoAl_2$ melted under an overpressure of 5 atm of argon with a tungsten electrode, as well as of buttons samples of HoN and DyN prepared from holmium and dysprosium metals under an overpressure of 2 to 5 atm of N_2, showed no indication of impurities. From titanium sponge, i.e., titanium metal, TiN of high purity was prepared with permanent or consumable electrodes under overpressures of 2 or 15 atm of N_2 respectively. ThN prepared under the same conditions contained minor impurities of higher nitride. In prepared melts of hot pressed mixtures of HfC and TaC, the HfC-rich solid solution was single phased, whereas the TaC-rich solid solution was multiphased. At these high melting points (>4000°C) the arc furnace could only be used to prepare small samples. (auth)

12455 ON THE PREPARATION OF BULK HOMOGENEOUS SPECIMENS OF ZIRCONIUM HYDRIDES. Barraclough, K. G.; Beevers, C. J. (Univ. of Birmingham, Eng.). J. Nucl. Mater.; 33: 296-301(Dec 1969).

The preparation of bulk, homogeneous, crack-free, polycrystalline zirconium hydrides over a wide composition range (~$ZrH_{1.3}$ to $ZrH_{1.9}$) by the reaction of high purity hydrogen with zirconium is described. The control of the hydride composition is presented in detail and factors determining grain size are also considered. (auth)

12456 BORON/EPOXY SUPPORT STRUT FOR NON-INTEGRAL CRYOGENIC TANKAGE. Nadler, Max A.; Yoshino, Stan Y.; Darms, Fred J. Jr. (North American Rockwell Corp., Downey, Calif.). Sci. Advan. Mater. Process Eng. Proc.; 15: 179-207(1969).

From 15th National SAMPE Symposium and Exhibition, Los Angeles, Calif. See CONF-690436.

A prototype boron/epoxy strut for the support system of an advanced nuclear flight stage with a non-integral tankage configuration was designed and fabricated. Studies indicate utilization of this material will result in substantial systems weight reduction as well as savings up to six million dollars per flight vehicle over competing designs due to reduced insulation requirements. Data were generated and are presented on properties of various cryotemperature mechanical and thermal arrays of boron/epoxy plastic composites. (auth)

12457 DIBORIDE MATERIALS, CANDIDATES FOR AEROSPACE APPLICATIONS. Clougherty, Edward V.; Peters, Edward T.; Kalish, David (ManLabs, Inc., Cambridge, Mass.). Sci. Advan. Mater. Process Eng. Proc.; 15: 297-308(1969).

From 15th National SAMPE Symposium and Exhibition, Los Angeles, Calif. See CONF-690436.

Polycrystalline diboride materials fabricated by hot pressing ZrB_2 or HfB_2 with refractory additives such as SiC and C are characterized by improved fabricability and enhanced material properties relative to the base diboride. Evaluations of material oxidation, and thermal, physical, and mechanical properties yield excellent relative ratings for the diboride materials compared with other candidate high-temperature materials. Environment centered and specific application oriented evaluations demonstrate that diboride materials should be considered for nosecaps, lifting re-entry leading edges, air breathing engine components, rocket nozzle throats, and other aerospace applications. (auth)

12458 PRODUCTION OF CERAMIC FUEL ELEMENTS FOR FAST BREEDERS. Michel, M. Atompraxis; 15: 416; 418-20 (Nov-Dec 1969). (In German).

Owing to its long experience in providing of fuel for the reactors Rapsodie, Rapsodie fortissimo, Masurca and Phenix, and to its research activity together with the CEA, the SICN is now ready to accept orders for fuel supply of fast breeders and to execute them at the best conditions. (auth)

12459 SINGLE CYCLE FABRICATION OF SINTERED UO_2 GRAINS FOR VIBRO-COMPACTED FUEL ELEMENTS. Flipot, A. J. (CEN, Mol, Belgium); Papeleux, P. Energ. Nucl. (Milan); 17: 46-52(Jan 1970).

Vibro-compacted UO_2 pins were fabricated from well-defined granulometric fractions. These granulometric fractions are generally obtained by grinding of fused uranium dioxide. As these methods require many recyclings because of the low yields per cycle, an improved high yield process was developed. Sintering directly of green pellet fragments and granules is not a convenient method because the yield of the desired granulometric fractions after crushing is very low. Furthermore, the particle size distribution range is extended by sintering. A new fabrication method was developed which produces, in one cycle, the required granulometric fractions avoiding the necessity to recycle. The process is based on obtaining granules which, after sintering, supply the medium fraction. The rest of the granulated powder is then pelletized into nodules of a few millimeter diameter which represent the coarse fraction. The fine fraction is obtained by milling the other two fraction rejects. The method is economical, simple, and versatile. The fabrication process does not require excess starting material and is therefore also suited to small quantities. The shape of the obtained grains makes vibro-compacting easier and enables realization of vibro-compacted irradiation pins containing a central thermocouple. (auth)

Properties Evaluations

Refer also to abstracts 12412, 12457, 12669, 12670, 12673, and 12897.

12460 (AECL-3422) STRENGTH DISTRIBUTION AND FRACTURE BEHAVIOUR OF STRUCTURAL CERAMICS OF LOW NEUTRON ABSORPTION CROSS SECTION. Stevens, R.; Clausen, T. D. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Oct 1969. 23p. Dep. CFSTI (U. S. Sales Only). AECL $1.00.

As part of an investigation into the use of structural ceramics under tension in a nuclear environment, Lucalox, Poco graphite, and KT SiC were fractured in four-point bending tests. The zirconium alloy Ozhennite was used as a comparison metal. Weibull statistics were applied to the fracture stresses measured, and a method for estimating the zero stress, σ_w, described. Poco graphite was the ceramic with the most reproducible properties, but the variability in all three ceramics, as shown by their Weibull exponents, was considerably more than that for Ozhennite. Nevertheless the ceramics had sufficient short time strength at low probabilities of failure (e.g., ~5000 lb/in.^{2} at a failure probability of 10^{-4} per cent) for their application under tension to merit consideration. Work-of-fracture values for the ceramics were approximately 5×10^{-4} erg/cm and are discussed in relation to their metallographic structure. (auth)

12461 (BARC-413) CHARACTERISATION AND SINTERABILITY OF URANIA POWDERS. Moorthy, V. K.; Rao, S. V. K. (Bhabha Atomic Research Centre, Bombay (India)). 1969. 14p. Dep. CFSTI (U. S. Sales Only).

Uranium dioxide is now generally accepted as nuclear fuel for power reactors. For this application sintered pellets of high density (greater than 92%) and desired physical properties are required. The sintering behavior of the powders, the conditions of sintering required to attain the desirable density and microstructure—which control the physical properties, such as thermal conductivity, irradiation stability etc.—depend on the characteristics of UO_2 powders. The sintering behavior of UO_2 powders derived from various parent compounds by calcination and reduc-

tion at different temperatures were studied. The physical properties of the powders such as, surface area and crystal size were studied. Attempts were made to correlate the sintering behavior with the physical properties. It was found that the streaming potential of the powder is more directly related to its sintering behavior and encompasses the various factors influencing the sinterability of the powders. (auth)

12462 (BNWL-1223, pp 2.1-28) FAST REACTOR CERAMIC FUELS RESEARCH. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The creep rate of polycrystalline UO_2-20 wt % PuO_2, 96% dense was determined under various loads in four-point bending at 1475 and 1560°C. The activation energy was determined to be 110.0 kcal/mole. A study of the dependence of strain rate on stress indicated that the creep rate at a given stress depended on the previous stresses which had been applied to the sample. The initial creep test capsule was irradiated in the K-East Reactor specialty irradiation facility for 144 hr. The capsule was removed and examined. The heat transfer fluid (tin) had spilled from the containers and the specimens were broken. An improved design is being prepared. The thermal diffusivity of "round robin" UO_2 specimens was measured from room temperature to 2500°C. Major improvements and additions to the scanning electron microscope were completed to substantially increase the information content of micrographs produced on this instrument. An x-ray spectrometer to permit semi-quantitative analyses of observed microstructures and a rapid scan device was added to the instrument. A hot stage, capable of about 1600°C, is currently under design. A preliminary measurement was made of the viscosity of liquid UO_2 just above the melting point. Stable pendant drops were not formed on UO_2 rods 0.22 in. in diameter. This indicates that the surface tension of liquid UO_2 must be less than 600 dynes/cm if the liquid density is approximately 8.7 g/cm^3. Two attempts were made to measure the compressibility of molten UO_2. Both have resulted in furnace failures just above the melting point of UO_2. An apparatus for measurement of thermal expansion of irradiated mixed oxide fuel is nearly complete. Measurements are being performed to determine the accuracy and precision of the present technique for measuring O/M ratios on nonstoichiometric mixed oxides. Another technique for determination of O/M ratios on milligram size samples is under development. (auth)

12463 (CEA-CONF-1466) MEASUREMENT OF THE THERMAL RIGIDITY MODULUS $E_d\alpha$ OF A HEAT-INSULATING CONCRETE UNDER THERMAL STRESSES. Dubois, F. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); Noel, G. (Centre Experimental de Recherches et d'Etudes du Batiment et des Travaux Publics, Paris (France)). 1969. 36p. (In French). (CONF-691112-2). Dep. CFSTI (U. S. Sales Only).

From 2nd Conference on Prestressed Concrete Reactor Vessels and their Thermal Insulation, Brussels, Belgium.

The thermal stresses in insulating concretes were studied experimentally by means of a testing device which loads, under a constant moment, a prismatic girder of constant cross section, and puts it under a temperature difference between the hot and cold faces. On applying to this girder, a constant bending moment so that the neutral plane could remain horizontal, a mechanical effect, equal and opposite to the thermal effect, was created on the girder. The thermal rigidity modulus $E_d \cdot \alpha$ (E_d = total deformation modulus, α = thermal expansion coefficient) is expressed in $kg \cdot cm^{-2} \cdot °C^{-1}$. The testing machine with its hydraulic and temperature control devices is described. The measurement devices for displacement, pressure, temperature, and stress are also described. Heat insulating concretes containing expanded clays were tested under temperature gradients of about 320°C with a 30 cm thick testing girder. The results show the good mechanical and insulating properties of such concretes and also the fall of thermal rigidity modulus. (France)

12464 (WAPD-TM-880) EFFECT OF CARBOWAX BINDER AND DEXTROSE ADDITIVE ON THE MICROSTRUCTURE, DENSITY, AND OPEN POROSITY OF THORIA-URANIA FUEL PELLETS (LWBR DEVELOPMENT PROGRAM). Burke, T. J. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Nov 1969. Contract AT(11-1)-Gen-14. 40p. Dep. CFSTI.

The method and results are presented for an investigation to determine the effects of adding various amounts of glucose to thoria-urania systems agglomerated with 1, 2, and 3 wt % Carbowax 6000 binder. The effects reported are porosity, sintered density, and microstructure with respect to cold compacted fuel pellets covering a wide range of pellet densities. (auth)

12465 HOW REFRACTORIES IN CONTACT WITH VARIOUS TYPES OF GLASS BEHAVE AT THEIR FORMATION TEMPERATURES. Recasens, J.; Sevin, A.; Gardiol, M. Verres Refract.; 23: 19-27(Jan-Feb 1969). (In French).

Results obtained in the laboratory concerning the behavior of different types of glass in contact with refractories under the conditions prevailing in the fusion chamber are presented. The corrosion test results are classified by increasing aggressivity, determined according to the wear at the indentation in the refractory product. The glasses are categorized as very low wear: neutral types of glass and lead borosilicates; low wear: glass for television and fibers; and high wear: textile glass (E type glass). The test results confirm the superiority of high zirconia content electromelt refractories, especially when they are oxidized. An explanation is offered of attack of refractories by glass based on their order of basicity. (Sum. Articles Fr. Tech. Press)

12466 THE INFLUENCE OF LOCAL THERMAL STRESSES OF PORE DEFORMATION AND MIGRATION IN CERAMIC FUEL ELEMENTS. Weeks, R. W.; Li, Che-yu (Argonne National Lab., Ill.). J. Nucl. Mater.; 33: 318-19(Dec 1969).

The presence of an initially spherical pore in a thermal gradient causes a local disturbance of the temperature profile, and this disturbance leads to local thermal stresses. These local stresses vary across the pore and can influence pore deformation. The magnitude of these local thermal stresses on the migration and deformation of an initially spherical pore in a uranium dioxide fuel element was examined. (G.M.C.)

12467 ANALYSIS OF BUBBLE RELEASE FROM DISLOCATIONS IN NUCLEAR FUELS. Weeks, R. W.; Scattergood, R. O. (Argonne National Lab., Ill.). J. Nucl. Mater.; 33: 333-6 (Dec 1969).

The release of fission-gas bubbles from dislocations in nuclear fuel was analyzed. The dislocation stretching model and the interaction energy model for bubble release are discussed. (G.M.C.)

12468 THE STRENGTH AND FRACTURE OF STOICHIOMETRIC POLYCRYSTALLINE UO_2. Evans, A. G.; Davidge, R. W. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater.; 33: 249-60(Dec 1969).

The strength of stoichiometric polycrystalline UO_2 was determined from 20 to 1500°C for material of two grain sizes. It was found that the fine grained (~8 μm) material was always stronger than the larger grained (~25 μm) material. A ductile-brittle transition was observed in both materials at ~1200°C. Below the transition temperature, two modes of fracture were observed. At low temperatures, the fracture stress increased with increase in temperature; fracture occurred by the extension of the large pores which remained after cold pressing and sintering. At intermediate temperatures the strength decreased with increase in temperature; fracture was initiated by plastic flow and occurred at the macroscopic yield stress. (auth)

12469 CONTRIBUTION TO THE STUDY OF THE MECHANISMS OF THE BEGINNING OF SINTERING OF URANIUM DIOXIDE. Bacmann, J. J. (Centre d' Etudes Nucleaires, Grenoble, France); Cizeron, G. J. Nucl. Mater.; 33: 271-85(Dec 1969). (In French).

Sintering kinetics of UO_2 compacts (using three different types of powder) were studied by recording their isothermal shrinkage under hydrogen between 700 and 1400°C in a high temperature dilatometer. A constant activation energy of 95 kcal/mole was found all over this temperature range, showing no influence of size and morphology of particles. This value is similar to the activation energy of uranium diffusion in UO_2, which suggests that the sintering process in UO_2 is not controlled by oxygen diffusion. When diffusion coefficients of uranium calculated from sintering data are compared to those deduced from radiotracer experiments, it is rather difficult to decide between a volume and/or a grain boundary diffusion mechanism. However, isothermal shrinkage curves can be more satisfactorily interpreted when a sintering theory based on grain boundary diffusion is considered. (auth)

12470 NITROGEN DIFFUSION IN URANIUM NITRIDE AS MEASURED BY ALPHA PARTICLE ACTIVATION OF ^{15}N. Holt, J. B.; Almassy, Marcia Y. (Univ. of California, Livermore). J. Amer. Ceram. Soc.; 52: 631-5(21 Dec 1969).

A new technique, based on the nuclear activation reaction $^{15}N(\alpha,n)^{18}F$, was used to measure nitrogen self-diffusion coefficients in UN. Temperatures were 1700 to 2000°C and N_2 pressures 7 to 603 torr. The diffusion coefficients were in fair agreement with those obtained by the gaseous exchange method in an independent study. No fundamental significance was attached

to the activation energy because UN is nonstoichiometric under these conditions, and the relation between composition and N_2 pressure is unknown. The results are compatible with nitrogen interstitial diffusion. (auth)

12471 PLASTICITY AND CREEP IN SINGLE CRYSTALS OF ZIRCONIUM CARBIDE. Lee, D. W.; Haggerty, J. S. (Arthur D. Little, Inc., Cambridge, Mass.). Contract AT(30-1)-3411. J. Amer. Ceram. Soc.; 52: 641-7(21 Dec 1969).

High-temperature deformation in ZrC single crystals was studied. Seeded crystals were grown by a direct rf-coupling floating-zone process. Yield stresses were measured from 1080 to 2000°C as a function of stress axis orientation. The Burgers vector was shown to be parallel to the ⟨110⟩ axes by transmission electron microscopy. Slip was observed on {100}, {110}, or {111} planes, depending on the orientation of the stress axis; it always occurred on the most favorably oriented slip system. The dependence of steady-state creep rate on the applied stress indicated that recovery occurred by a dislocation climb mechanism. Examination of the dislocation structure in deformed crystals by transmission electron microscopy supported this conclusion. (auth)

12472 ADVANCED COMPOSITE MATERIAL APPLICATIONS IN FUTURE BOOSTERS AND SPACECRAFT. Korb, Lawrence J. (North American Rockwell Corp., Los Angeles). Sci. Advan. Mater. Process Eng. Proc.; 15: 1-28(1969).

From 15th National SAMPE Symposium and Exhibition, Los Angeles, Calif. See CONF-690436.

The pressing need for more efficient space vehicle structures will require the application of more efficient materials. Advanced composites, which employ boron fibers in plastic or metal matrices, have three to five times the specific strength and stiffness of current structural alloys used in the Saturn and Apollo vehicles. Current and future space vehicles are reviewed and an analysis of applications where composites would be more effectively used both structurally and economically is presented. (auth)

12473 COMPARISON OF BORON–EPOXY AND BORON–ALUMINUM COMPOSITES. Davis, L. W. (Harvey Engineering Labs., Torrance, Calif.). Sci. Advan. Mater. Process Eng. Proc.; 15: 67-74(1969).

From 15th National SAMPE Symposium and Exhibition, Los Angeles, Calif. See CONF-690436.

With both boron-epoxy and boron-aluminum composites now available commercially, it is desirable to make a comparison of various properties to provide designers with some guidance in the selection of materials. This comparison includes strength/weight and modulus/weight ratios but many other properties must also be taken into consideration. Transverse strengths of unidirectional composites, shear strengths, endurance limit and other mechanical properties are compared. Physical properties such as moisture absorption and resistance to corrosion are also discussed. Finally, both present and projected costs are examined so that selection of materials can be made on a sound basis. (auth)

12474 EVALUATION OF BORON–ALUMINUM COMPOSITE MATERIAL FOR SPACE STRUCTURES. Happe, Ralph A.; Yeast, Allan J. (North American Rockwell Corp., Los Angeles). Sci. Advan. Mater. Process Eng. Proc.; 15: 75-89(1969).

From 15th National SAMPE Symposium and Exhibition, Los Angeles, Calif. See CONF-690436.

Results of a program to explore the possibilities for utilizing boron-aluminum composite sheet material are reported. Vehicle application studies, forming, machining, and joining studies are summarized. Conclusions and indications for future efforts are included. (auth)

12475 MECHANICAL PROPERTIES OF BRAZE-BONDED BORSIC–ALUMINUM COMPOSITES. Carlson, C. E.; Delgrosso, E. J.; Varholak, E. M. (Hamilton Standard, Windsor Locks, Conn.). Sci. Advan. Mater. Process Eng. Proc.; 15: 101-15 (1969).

From 15th National SAMPE Symposium and Exhibition, Los Angeles, Calif. See CONF-690436.

Fully-dense BORSIC-aluminum composites have been fabricated from BORSIC-aluminum tapes using a newly developed low-pressure braze bonding technique. The tensile and structural properties of these braze-bonded composites compared favorably with the same properties of composites prepared using the standard high-pressure diffusion bonding method. (auth)

12476 POLYIMIDE RESIN IN BORON REINFORCED COMPOSITES. Jones, J. F.; Vaughan, R. W.; Burns, E. A. (TRW Systems, Redondo Beach, Calif.). Sci. Advan. Mater. Process Eng. Proc.; 15: 163-9(1969).

From 15th National SAMPE Symposium and Exhibition, Los Angeles, Calif. See CONF-690436.

Accurately collimated boron monofilament reinforcement preimpregnated with P13N polyimide resin was laminated into test specimens and evaluated for flexural strength, flexural modulus, interlaminar shear strength, and thermal aging characteristics at 550°F. Exploratory studies were conducted to determine the optimum staging temperatures and times for preparing prepregs, and it was determined that approximately 200 boron filaments per inch provided maximum strengths. The average flexural strength of 37% v/v boron loaded was 222 ksi, 178 ksi and 148 ksi for specimens at room temperature and 550°F, respectively. Flexural modulus values were generally over 20 million psi. Interlaminar shear strengths at room temperature averaged 9870 psi. Advantages of the P13N polyimide resin over the use of other commercially available polyimide resin systems appear to be the combination of thermal stability, adhesion to the reinforcement, ease of processing, long shelf life of the prepreg, and low void content of the final product. (auth)

12477 MIXED BORON COMPOSITES FOR SOLID ROCKET NOZZLES. Warga, Joseph J. (Aerojet-General Corp., Sacramento, Calif.). Sci. Advan. Mater. Process Eng. Proc.; 15: 171-8(1969).

From 15th National SAMPE Symposium and Exhibition, Los Angeles, Calif. See CONF-690436.

Laminates of glass overlaid boron filaments interleaved with carbon and silica fabrics were prepared by press molding the prepreg materials. The laminates were tested to determine their mechanical and physical properties at room and elevated temperatures. Ablative properties were evaluated by observation of their performance in subscale solid rocket motor tests. (auth)

12478 MULTI-FOIL THERMAL INSULATION. Paquin, Michael L. (Thermo Electron Corp., Waltham, Mass.). Sci. Advan. Mater. Process Eng. Proc.; 15: 465-78(1969).

From 15th National SAMPE Symposium and Exhibition, Los Angeles, Calif. See CONF-690436.

The exceptional properties of MULTI-FOIL, a vacuum thermal insulation is discussed. MULTI-FOIL consists of many layers of thin metal foil separated from one another by high purity oxide particles. The foils serve as thermal radiation shields and the oxide particles prevent metal-to-metal contact without contributing greatly to the conduction losses. Laboratory measurements have established that MULTI-FOIL insulation has an exceptionally low thermal conductivity and is effective from cryogenic temperatures to temperatures as high as 3500°F. (auth)

Structure and Phase Studies

12479 (AECL–3472) RECOVERY AND RECRYSTALLIZATION OF U_3Si. Caillibot, P. F.; Wyatt, B. S. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Oct 1969. 26p. Dep. CFSTI (U. S. Sales Only). AECL $1.00.

The recovery and recrystallization temperatures of U_3Si were determined for an alloy of uranium-3.98 wt % silicon containing 600 ppM carbon. Small specimens, deformed by compression, were isothermally and isochronally annealed at 350 to 700°C and their recovery and recrystallization temperatures determined using hardness, grain size, and x-ray measurements. Strain and an annealing time of 6 hours was sufficient to initiate both recovery and recrystallization at 400 to 450°C in small specimens. Complete recrystallization is achieved at 650 to 700°C. The effect of small changes in silicon and carbon concentration was determined by examining two further alloys containing 3.27 wt % silicon and 600 ppM carbon, and 4.02 wt % silicon and 140 ppM carbon respectively. A small change in silicon concentration does not affect recovery and recrystallization but decreasing the carbon concentration from 600 to 140 ppM decreases the recovery and recrystallization temperatures. (auth)

12480 (MLM–1704(tr)) CRYSTALLOGRAPHIC STUDY OF THE ERBIUM–SELENIUM SYSTEM. Guittard, Micheline; Flahaut, Jean. Translated by D. Hastings (Mound Lab., Miamisburg, Ohio), from Compt. Rend., Ser. C; 264: 1951-4(1967). 7p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 21: 41669.

12481 PHASE RELATIONS IN THE VO_2–WO_2 SYSTEM. Israelsson, Mats; Kihlborg, Lars (Univ. of Stockholm). Mater. Res. Bull.; 5: 19-30(Jan 1970).

The pseudo-binary system V_xW1-_xO2 was studied by x-ray powder diffraction methods after heat treatment of the samples at 1100°C. The phases observed are all structurally closely related to rutile and are of monoclinic WO_2 type ($0 \leq x \leq 0.150$); monoclinic, slightly distorted rutile type ($0.215 \leq x \leq 0.327$); tetragonal rutile type ($0.333 \leq x \leq 0.983$) with tri-rutile superstructure around $x = 0.67$, and monoclinic VO_2 type ($0.987 \leq x \leq 1$). The variation of the unit cell parameters with composition has been studied for all these phases. (auth)

12482 SLIP SYSTEM OF TUNGSTEN CARBIDE CRYSTALS A ROOM TEMPERATURE. Luyckx, S. B. (Univ. of Witwatersrand, Johannesburg). Acta Met.; 18: 233-6(Feb 1970).

Slip was nucleated in WC single crystals by means of bending and microindentations. The slip system was determined as being $\langle 2\bar{1}\bar{1}3\rangle\{01\bar{1}0\}$. (auth)

Radiation Effects

Refer also to abstracts 13525 and 13546.

12483 (BNWL-1223, pp 3.1-68) IRRADIATION BEHAVIOR OF FAST REACTOR FUEL MATERIALS. Christensen, J. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The melting heat rating for UO_2–25 wt % PuO_2 fuel was determined by precision methods to be 16.5 kW/ft for a fuel surface temperature of 950°C. Fission rate distribution in fuels of fast compositions irradiated in thermal fluxes were measured and correlated with analytical predictions. Measurements showed the effects of Xe contamination on fuel-sheath heat transfer to be small. Addition of 40, 60, and 100% Xe to the He fill gas in UO_2–25 wt % PuO_2 fuel pins resulted in respective decreases in gap conductance of 15, 25, and 45%. Detailed postirradiation evaluation of UO_2–25 wt % PuO_2 fuel pins irradiated to as high as 160,000 MWd/t in MTR/ETR is in progress. Clad deformations and in some cases gross failures were observed. Significant overall and local inheterogeneities in Pu and fission fragment concentration were observed with the shielded electron microprobe. Design of basic swelling experiments involving UO_2–25 wt % PuO_2 specimens is near completion. Existing stochastic models were shown to provide suitable input for CYGRO and DEFORM. Fuel-clad reactions and subsequent redistribution of clad constituents in the fuel were studied with the shielded microprobe and described in terms of the thermodynamics of fuel-clad-fission product systems. A basic model which describes fuel constituent migration in response to concentration temperature, and thermoelectric potential gradients typical of oxide fast fuels, is being formulated. (auth)

12484 (BNWL-1223, pp 6.1-3) RADIATION EFFECTS ON ABSORBING MATERIALS FOR CONTROL RODS. Pitner, A. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

A subassembly containing boron carbide specimens was discharged from a Hanford reactor after an estimated 3% ^{10}B burnup. Sample temperatures ranged from 550 to 1130°F. The boron-carbide was in five forms: 60 and 80% TD powder, and 65, 90, and 99% TD pellets. All samples showed apparent high gas release, and the pellets exhibited considerable degradation as a result of the irradiation. Most severe deterioration was in the highest density pellets (99% TD), in which the surface became powdery. (auth)

12485 (BNWL-1223, pp 7.1-3) NUCLEAR GRAPHITE. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The c-axis lattice thermal expansion of POCO grade AXZ-5Q1 graphite was measured both before and after irradiation at 1000 to 1100°C to 1.2×10^{22} n/cm^2. The average coefficient of thermal expansion between 25 and 425°C for the unirradiated material was $27.1 \pm 1.0 \times 10^{-6}$/°C; for the irradiated material it was $26.8 \pm 3.0 \times 10^{-6}$/°C. This is within the accepted value of 27.8×10^{-6}/°C for single crystals. The graphite oxidation program is being modified to enable calculation of the 1100 MW(e) HTGR graphite chemistry system. An additional 360,000 Ci of ^{60}Co was added to the gamma irradiation facility. The total amount of ^{60}Co in the source was 620,000 Ci. The maximum dose rate was 3.87×10^7 R/hr as determined by ceric sulfate dosimetry. An apparatus is being modified to study the radiolytic rate of reaction of CO_2 with H_2 in the 100 to 1000 vpM range in helium. (auth)

12486 (N-70-11396) POSTIRRADIATION ANALYSIS OF HIGH-TEMPERATURE, LOW-BURNUP TUNGSTEN-URANIUM DIOXIDE TEST PLATES. Ball, Lauren L.; Sheibley, Dean W. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Nov 1969. 11p. (NASA-TM-X-1872). CFSTI.

Problems in determining fuel burnup of high temperature tungsten-uranium dioxide fuel plates were resolved by using tungsten 184 as a thermal flux monitor. Methods for determining fission product releases from fueled test plates were evaluated. The use of fission product cesium-137 as a burnup monitor was also evaluated. (auth)(STAR)

12487 (RD/B/N-1489) IRRADIATION CREEP OF URANIUM DIOXIDE. Sykes, E. C.; Sawbridge, P. T. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Nov 1969. 14p. Dep. CFSTI (U. S. Sales Only).

The irradiation induced creep of UO_2 was measured in-pile by observing the deflections of helical springs placed in compression. Preliminary analysis of the results of the first two tests indicates $\dot{\epsilon}_i \sim 10^{-10} \cdot R \cdot \sigma$ where $\dot{\epsilon}_i$ = irradiation creep rate $\cdot hr^{-1}$; R = rating MW/te(u); σ = stress psi. (auth)(UK)

12488 (WAPD-TM-664) OBSERVATIONS ON THE IRRADIATION BEHAVIOR OF A ZIRCALOY-4 CLAD ROD CONTAINING LOW DENSITY ThO_2–5.3 WT. PERCENT UO_2 PELLETS (LWBR DEVELOPMENT PROGRAM). McCauley, J. E. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Dec 1969. Contract AT(11-1)-Gen-14. 60p. Dep. CFSTI.

A rod-type fuel element, containing low density ThO_2–5.3 wt % UO_2 fuel pellets and sheathed in Zircaloy-4, was irradiated to a peak depletion of 1.5×10^{20} fissions per cubic centimeter of oxide fuel. The element was located in a relatively steep thermal flux gradient during its entire irradiation lifetime. Post-irradiation observations of grain growth and central void formation in this oxide fuel were found to be reasonably consistent with current theoretical treatments of these phenomena. The irradiation history defined for rod 79-76 as a function of specimen axial location and in-reactor test time, was supported indirectly by a semi-quantitative evaluation of the microstructural changes obtained in the oxide pellets. (auth)

12489 IRON IN SYNTHETIC QUARTZ: HEAT AND RADIATION INDUCED CHANGES. Cohen, Alvin J.; Hassan, Farkhonda (Univ. of Pittsburgh). Science; 167: 176-7(9 Jan 1970).

As part of a study of the possible changes in silicate material on the lunar surface produced by solar radiation, effects of ionizing radiation, of heating, and of heating followed by ionizing radiation on iron-doped synthetic quartzes have been studied as models. The optical changes are mainly related to valence changes in ferric or ferrous ions. (auth)

12490 THE ANISOTROPIC EXPANSION OF NEUTRON IRRADIATED BERYLLIUM OXIDE, ZINC OXIDE, AND ALUMINUM NITRIDE. Sabine, T. M. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). J. Nucl. Mater.; 33: 340-2(Dec 1969).

Neutron irradiation of BeO, ZnO, and AlN resulted in anisotropic expansion of their lattice parameters. This anisotropy is shown to be due to the existence in these compounds of clusters of defects in the basal plane where these clusters constitute dislocation loops with Burgers vector along the normal to the loop. (G.M.C.)

Plastics and Other Materials

Refer also to abstracts 11631, 12416, 12451, 12456, 12465, 12476, and 13589.

12491 (AEEW-R-482) DIFFUSION OF WATER IN CONCRETE. Hancox, N. L. (Atomic Energy Establishment, Winfrith (England)). Aug 1966. 43p. Dep. CFSTI (U. S. Sales Only).

Radiation attenuating properties of a nuclear reactor concrete biological shield are influenced by the amount of free water in the concrete and the mechanism and rate of drying. This study of the drying of concrete spheres has indicated the role of diffusion in this process and the influence of temperature, moisture content and porosity upon the diffusion coefficient. Attempts to produce a moisture gage for the nondestructive determination of the free water content of shield concrete are reported. (auth)

12492 (AERE-M-2269) USE OF WOOD-PLASTIC COMPOSITES BY THE FLOORING INDUSTRY. Hills, P. R. (United Kingdom Atomic Energy Authority, Wantage (England). Research Group). Nov 1969. 9p. Dep. CFSTI (U. S. Sales Only). UK 2s. 6d.

The properties of wood-plastic composites, products formed by the radiation initiated polymerization of monomers in wood, are enumerated. The advantages are stressed and the methods by which they are worked stated. The present applications of wood-plastic composites are mentioned and the potential value to the

flooring industry stressed. The production capabilities of the U.S.A. and U.K. are discussed. (UK)

12493 (BNL-14267) CONCRETE-POLYMER COMPOSITES FOR UNDERWATER APPLICATIONS. Kukacka, L. E.; Colombo, P.; Steinberg, M.; Manowitz, B. (Brookhaven National Lab., Upton, N. Y.). [1969]. 18p. (CONF-691204-1). Dep. CFSTI.

From Conference on Civil Engineering in the Oceans II, Miami, Fla.

Studies indicated that remarkable improvements in the structural and durability properties of concrete can be obtained by monomer impregnation and in situ polymerization by either radiation or thermal-catalytic means. A total of four monomer systems being considered for normal temperature applications are currently under tests. A series has also been prepared with monochlorostyrene but the test results are not yet available. The results generally indicate that the compressive and tensile strengths and the modulus of rupture are markedly increased by polymer loading. Concrete impregnated with a methyl methacrylate +10% TMPTMA mixture gave the greatest improvement in compressive and tensile strengths. The thermally treated concrete-polymer materials generally had a lower strength value than radiation-treated material. Differences in the order of 12 to 17% were observed. With styrene, the differences were ~35%. In general, methyl methacrylate-impregnated specimens had the greatest improvement in durability properties. No failures occurred after exposures of >1 yr to sulfate brines and 15% hydrochloric acid. Exposure to 5120 cycles of freezing and thawing resulted in essentially no attack. A test life of 500 cycles was considered to be indicative of a concrete with good resistance to freeze-thaw. Acrylonitrile-impregnated specimens gave the smallest improvement in durability properties of the monomers tested. The degree of improvement appears to be a function of polymer content rather than of the method of initiating the polymerization. Steel fiber-reinforced concrete impregnated with methyl methacrylate exhibited compressive strengths up to 23,828 psi which corresponded to an increase of 383% over the unimpregnated reinforced control and 477% over the nonreinforced control. Pull-out bar tests made on concrete-polymer containing steel reinforcing rods indicate bond strengths up to 700 psi, an improvement of 194% over that for the control. Potential applications for concrete-polymer systems are discussed. (J.C.W.)

12494 RADIATION ELECTROCONDUCTIVITY AND CREEP IN POLYMERS. Vaisberg, S. E.; Sichkar, V. P.; Stepanov, V. F.; Karpov, V. L. Vysokomol. Soedin., Ser. A; 11: 2577-84(Nov 1969). (In Russian).

Dependences of polyethylene radiation electric conductivity on the dose rate and on temperature and of polycaproamide creep on the dose rate, temperature and loading were experimentally studied. Similar dependences are valid for both types of properties. Hypotheses on the nature of radiation creep in polymers were advanced, including rupture of the strained bonds by interactions with thermal electrons generated by irradiation. The theory of Fowler-Rose can be applied to both radiation electric conductivity and creep, strained bonds act as electron traps. Some consequences of the concept were proven experimentally. (auth)

12495 CHARACTERIZATION OF COATINGS: PHYSICAL TECHNIQUES. PART I. Myers, Raymond R.; Long, J. S. (eds.). Treatise on Coatings. Volume 2. New York; Marcel Dekker, Inc. (1969). 785p. $39.75.

Thirteen chapters are included. A separate abstract was prepared for Chapter 9 on radioisotopes. The remaining chapters include information on the intrinsic properties of polymers; surface areas; adhesion of coatings; mechanical properties of coatings; the ultimate tensile properties of paint films; gas chromatography; thermoanalytical techniques; microscopy in coatings and coating ingredients; infrared spectroscopy; ultraviolet and visible spectroscopy; color of polymers and pigmented systems; and photoelastic coatings. (J.G.B.)

For an abstract of the individual chapter see: 11738.

12496 RADIATION STABILITY OF UNFILLED PYRRONE MOLDINGS. Price, Howard L.; Bell, Vernon L. (Langley Research Center, Hampton, Va.). Sci. Advan. Mater. Process Eng. Proc.; 15: 335-47(1969).

From 15th National SAMPE Symposium and Exhibition, Los Angeles, Calif. See CONF-690436.

An investigation has been made of the stability of unfilled Pyrrone moldings to electron irradiation in air. Previous radiation data have shown that Pyrrone films made with pyromellitic dianhydride retained their mechanical properties after doses up to 50,000 megarads. The investigation included preparing the molding powder from benzophenone tetracarboxylic acid dianhydride and diaminobenzidine in either dimethylacetamide or ethylene glycol. A workable but not necessarily optimum molding procedure was developed in order to form the powder into parts which were suitable for mechanical testing. The molded parts were cut into test specimens for flexural tests at elevated temperatures to 600°F, and after exposure to electron radiation in air, to doses of 50,000 megarads (5×10^{10} rad). (auth)

12497 MATERIALS IN A NUCLEAR ENVIRONMENT. Hughes, John P.; Schmitz, Fred J. (Argonne National Lab., Ill.). Sci. Advan. Mater. Process Eng. Proc.; 15: 349-60(1969).

From 15th National SAMPE Symposium and Exhibition, Los Angeles, Calif. See CONF-690436.

In recent years considerable progress has been made in understanding the fundamental chemical reactions that occur when materials are irradiated. Of great importance is the demonstration that chemicals can be manufactured by radiation chemical processes which are the effect of radiation. These same processes are a cause for failure of materials in a nuclear environment. Two materials, polyimide and a copolymer of styrene and alpha-methylstyrene, illustrate how they can be affected by a radiation chemical process. The effect of neutrons and gamma radiation from a nuclear reactor irradiation of polyimide is determined by its structural integrity and physical properties. The effect of gamma radiation on the insulating copolymer film of a capacitor is measured by a dosimeter. (auth)

12498 CARBON MATERIALS. Suzuki, Hiroshige; Kimura, Shushichi (Tokyo Inst. of Tech.). J. Mater. Sci. Soc. Jap.; 6: No. 1, 23-32(Mar 1969). (In Japanese).

Carbon materials of high purity and radiation resistance are in great demand in the nuclear industry because of their superior nuclear properties, low cost, and high heat-resistance. Carbon materials, with emphasis on graphites, are considered under the following topics: crystal structure and microstructure; physical properties, including thermal expansion and thermal conductivity, electrical and mechanical properties; and chemical properties. (NSA of Japan)

12499 DIELECTRIC BEHAVIOR OF SOME IRRADIATED POLYMERS. Matveev, V. K.; Vaisberg, S. E.; Karpov, V. L. (Inst. of Physics and Chemistry, Moscow). Vysokomol. Soedin., Ser. A; 11: 2666-70(Dec 1969). (In Russian).

The effects of γ radiation on electrons in vacuum and in air on the dielectric behavior of polyethylene, polypropylene, polystyrene, and poly-α-methylstyrene were studied for a wide range of doses (to 800 Mrad) and dose rates (to 7.3×10^4 rad/sec). Dependence of tg δ on the dose of γ radiation in air was determined for all the polymers. The increase of tg δ on irradiation in air is related to radiation oxidation. The latter has diffusion character and the increase of tg δ is determined not only by the dose, but mainly with the time of contact with oxygen. For polyethylenes a formula is found (for 200 to 300 rad/sec) that relates tg δ to the radiation dose in air, thickness, and crystallinity of the sample. Tg δ of polyethylene irradiated in a vacuum increased on storing in air, which caused migration of radicals from the crystalline phase. (auth)

PHYSICS (GENERAL)

Astrophysics and Cosmology

12500 INFRARED ASTRONOMY. Webbink, Ronald F.; Jeffers, William Q. (McDonnell Douglas Corp., St. Louis). Space Sci. Rev.; 10: 191-216(Nov 1969).

This review is a survey of infrared astronomy up to early 1969. The techniques and photometric standards are mentioned briefly, and results cover solar, lunar, and planetary observations. Point sources and extended sources both within and beyond the Galaxy are included, ending with the problem of cosmic background radiation. It is concluded that great progress will be possible when large infrared telescopes are placed above the atmosphere in orbit for extended periods of time. (auth)

Cosmic Ray Exposure Ages

Refer also to abstracts 11466 and 13340.

12501 ^{196}Hg AND ^{202}Hg ISOTOPIC RATIOS IN CHONDRITES. Reed, G. W.; Jovanovic, S. (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem.; 31: 3783-8(Dec 1969).

An apparent discrepancy has been observed in the isotopic composition of ^{196}Hg and ^{202}Hg in a few of the fractions collected during volatilization of Hg from chondritic meteorites. So far, a generally acceptable radiochemical explanation of these occurrences has not been found but this search should be further exhausted before these results are accepted as anomalies. (auth) (UK)

12502 ON THE EXISTENCE OF SUPER-HEAVY ELEMENTS NEAR Z = 114 AND N = 184 IN METEORITES. Rao, M. N. (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys.; A140: 69-73(1970).

The observed excess abundance of ^{136}Xe and ^{86}Kr in primitive chondritic meteorites can be attributed to spontaneous fission of the superheavy elements (near Z = 114 and N = 184 decaying through symmetric and asymmetric fission modes, respectively. (auth)

12503 RADIOACTIVE ISOTOPES IN HOBA WEST AND OTHER IRON METEORITES. McCorkell, R. H. (Smithsonian Astrophysical Observatory, Cambridge, Mass.); Fireman, E. L.; D'Amico, J.; Thompson, S. O. Meteoritics; 4: 113-22(Oct 1968).

Isotope studies were performed on the largest known meteorite fragment, the 60-ton high-nickel ataxite Hoba West, found in Southwest Africa in 1920. This study of the radioactivities and rare-gas isotopes in Hoba was undertaken to obtain both a terrestrial age and better information on the preterrestrial size and cosmic-ray exposure age. For comparison, the ^{36}Cl and rare-gas isotopes were measured in Deelfontein, as were the ^{36}Cl and ^{59}Ni in Sikhote-Alin, the latter because it is a large iron meteorite of dated fall. The ^{59}Ni is important as a neutron-produced isotope that could be used for evaluating the neutron effects of solar flares. Results of the radioactivities ^{10}Be, ^{26}Al, ^{36}Cl, ^{53}Mn, ^{59}Ni, and ^{60}Co are given. The spallation-produced radioactivities indicate that the Hoba sample was at a depth of 35 to 40 cm when the body was in space. The ^{59}Ni activity indicates that the terrestrial age of Hoba is less than 80,000 yr. Its ^{36}Cl/^{36}Ar exposure age is 263 ± 40 Myr. The ^{36}Cl and rare-gas isotopes measured in the Deelfontein meteorite indicated its ^{36}Cl/^{36}Ar exposure age is 400 ± 40 Myr. In both Hoba and Sikhote-Alin the ^{59}Ni is higher than would be expected from the ^{36}Cl content, indicating that solar flares contributed to the neutron-produced isotopes in these iron meteorites. (BBB)

Stars

12504 THE SPECTRA OF SOME Be STARS. Jaschek, M.; Jaschek, C.; Malaroda, S. (Univ. Nacional, La Plata). Astron. Astrophys.; 3: 485-7(Dec 1969).

Short descriptions of the spectra of 31 Be stars are given. (auth)

12505 HOT WHITE DWARFS. Hubbard, W. B.; Wagner, Raymond L. (Univ. of Texas, Austin). Astrophys. J.; 159: 93-100(Jan 1970).

A sequence of models of white dwarfs including corrections for nonideality in the equation of state has been computed for a typical white-dwarf luminosity. The mass–radius relations found by Hamada and Salpeter are appreciably modified by thermal effects, particularly for white dwarfs of low mass. Results for 40 Eri B, together with a recent determination of its radius, indicate a chemical composition heavier than helium. It is found that some white dwarfs exhibit a zone where electrons are strongly coupled, such that determination of the central temperature becomes difficult. (auth)

12506 PARENT MASSES OF CLUSTER WHITE-DWARFS. Jones, Eric M. (Univ. of Wisconsin, Madison). Astrophys. J.; 159: 101-6(Jan 1970).

An empirical limiting mass of 1.86 (−0.12, +0.48) $M_\odot$ is derived from the Hyades and from Procyon such that stars with an initial mass greater than the limit will become white dwarfs on the brighter of the two observed white-dwarf sequences. These are stars that have evolved cores of elements heavier than carbon and oxygen. Three new white-dwarf members are proposed for the Sirius moving-group. The mass limit is discussed in relation to the Pleiades, Praesepe, the Sirius group, and the 61 Cygni group. The results suggest that the Sirius group may not be a coeval aggregate. (auth)

12507 EVOLUTIONARY EFFECTS IN THE ROTATION OF SUPERGIANTS. Rosendhal, Jeffrey D. (Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J.; 159: 107-18(Jan 1970).

A statistical investigation was made of rotation and macroturbulence in early-type Ia and Iab supergiants. The study had two principal objectives: first, to see whether it is possible to separate the contributions to the observed line broadening arising from these two forms of macroscopic motion; second, if possible, to use the recovered rotational component to determine whether significant amounts of angular momentum have been lost during evolution away from the main sequence. The principal results were: (1) At all spectral types in the range B0–A5 both rotation and macroturbulence contribute to the observed line broadening. In the early B stars, rotation is as important a broadening agent as large-scale mass motion. In the middle-B and A stars turbulence dominates, but there still is an appreciable contribution from rotation. (2) In spite of the fact that the stars observed seem to be losing mass, there is no strong evidence for significant loss of angular momentum. (auth)

12508 ABSOLUTE SPECTROPHOTOMETRIC CALIBRATION OF THE ENERGY DISTRIBUTION OF TWELVE STANDARD STARS. Hayes, D. S. (Univ. of California, Los Angeles). Astrophys. J.; 159: 165-76(Jan 1970).

Energy distributions of α Lyr, κ Aql, 58 Aql, ϵ Aqr, 29 Psc, ξ^2 Cet, ϵ Ori, γ Gem, η Hya, α Leo, θ Crt, and θ Vir were calibrated with two Phillips standard-lamps having a tungsten-ribbon filament which were calibrated in Heidelberg in 1958 and 1966. The observations were made with a reflection-grating photoelectric spectrum scanner on the 36-inch Crossley reflector of Lick Observatory and cover the range 3200 to 10870 Å. The bandpasses were 45 Å from 3200 to 5556 Å and 30 Å from 5556 to 10870 Å. The results for the twelve stars are tabulated as $-2.5 \log F(1/\lambda)/F(1/\lambda_0)$, where λ_0 = 5556 Å. The statistical errors are ±3% from 3200 to 3800 Å, ±1% from 4000 to 5000 Å, ±3% from 5000 to 7000 Å, and ±2% from 7000 to 10870 Å. (auth)

12509 LINES OF NEUTRAL HELIUM IN O- AND B-TYPE STARS. Shipman, H. L.; Strom, S. E. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J.; 159: 183-93(Jan 1970).

The effect of ultraviolet line blanketing on predicted departures from LTE is investigated. Previous conclusions suggesting that departures are small for stars later than B_3 are not altered when ultraviolet blanketing is included in model calculations. New descriptions of line broadening for the He I diffuse triplet λ4471 and the diffuse singlet λ4922 have been used in conjunction with model atmospheres to investigate the behavior of these lines for O and B stars. Qualitative agreement with the observed behavior of these lines is found for a wide range of spectral types and luminosities. For stars later than B3, He abundances deduced from the observed strength of the strong triplet line λ4471 are found to agree extremely well with those observed by Hyland from the weak triplet λ4713. This strengthens the belief that departures from LTE are probably not significant in describing He line formation in this range of spectral types. A spectroscopic He abundance of about 0.10 ± 0.02 by number fraction is found to be representative for B stars of Population I. This value is in good agreement with the value recently suggested by Morton on the basis of his analysis of the mass–luminosity relation for B stars and with analyses of gaseous nebulae. It now seems possible to obtain reliable He abundances from observation of λ4471. This means that even

low-dispersion spectroscopic material can be used in estimating stellar He abundances. (auth)

12510 ANALYSIS OF THE BRIGHT O STAR IN THE GLOBULAR CLUSTER M3. Strom, Stephen E. (State Univ. of New York, Stony Brook. Smithsonian Astrophysical Observatory, Cambridge, Mass.); Strom, Karen M. Astrophys. J.; 159: 195-200(Jan 1970).

Von Zeipel 1128 is shown to be an unusual late O-type member of the globular cluster M3. From an analysis of its spectrum it is concluded that $M > 0.6\ M_{\odot}$ and that the He/H ratio in Von Zeipel 1128 is close to that of O and B stars of Population I. Despite the fact that other stars in M3 have metal deficiencies of at least a factor of 10, the measured strengths of N III and O II lines suggest much higher metal abundances in Von Zeipel 1128. Various speculations on the evolutionary history of this star are briefly presented. (auth)

12511 GRAVITATIONAL POLARIZATION IN SPHERICAL STELLAR SYSTEMS. Gilbert, Ira H. (Brandeis Univ., Waltham, Mass.). Astrophys. J.; 159: 239-46(Jan 1970).

The distortion or "polarization" of a spherical and isotropic stellar system caused by the presence of a test star at its center is analyzed. An integral equation for the "polarization" is developed, and a specific solution is found in the case of the isochrone cluster of Henon. The relation between this phenomenon and the theory of collisional relaxation in stellar systems is discussed. It is concluded that collective effects might decrease relaxation times by a factor of 2 or 3. (auth)

12512 GLOBULAR CLUSTERS NGC 6752 AND NGC 6362. Alcaino, Gonzalo. Astrophys. J.; 159: 325-31(Jan 1970).

A UBV photoelectric investigation on the southern globular clusters NGC 6752 and NGC 6362 was carried out at the Cerro Tololo Inter-American Observatory with the 36-inch and 60-inch reflectors. Seventy-one stars were observed an average of 1.7 times in NGC 6752 to apparent magnitude V = 15.50, and sixty-one stars were observed an average of 1.9 times in NGC 6362 to magnitude V = 15.73. No reddening was detected in NGC 6752 [E(B − V) = 0.00]. The true distance modulus is $(m - M)_0$ = 13.5, and the distance is 5.01 kpc. Both the ultraviolet excess and ΔV values are characteristic of clusters that have weak to very weak metal lines. NGC 6362 has an estimated reddening E(B − V) = 0.15, an apparent visual distance modulus (m − M) = 14.70, and a true distance modulus $(m - M)_0$ = 14.25. The distance is 7.08 kpc. (auth)

12513 EFFECTS OF THREE-BODY FORCES IN A NEUTRON STAR. Chanmugam, G. (Brandeis Univ., Waltham, Mass.). Phys. Rev.; 186: 1384-6(25 Oct 1969).

It is shown that three-body forces give significant contributions to the equation of state of a neutron star at high densities. (auth)

12514 ELECTROSPECTROPHOTOMETRY OF SELECTED STARS. Karetnikov, V. G.; Medvedev, Yu. A. (Odessa Astronomical Observatory). Astrophysics (Engl. Transl.); 3: 259-61 (Winter 1967).

Translated from Astrofizika; 3: 575-80(1967).

The spectra of ten stars were recorded photoelectrically. Dispersion is 125 Å/mm near H_γ. The energy distribution in the stellar spectra and the equivalent widths of hydrogen lines $H_\beta - H_\zeta$ were obtained. The results are compared with the data of Code, Kopylov, and Kharitonov. (auth)

12515 VARIABILITY OF POLARIZATION OF THE CRAB NEBULA. Khachikyan, E. E.; Einatyan, Dzh. A. (Byurakan Astrophysical Observatory, USSR). Astrophysics (Engl. Transl.); 3: 262-3(Winter 1967).

Translated from Astrofizika; 3: 581-4(1967).

Polarization measurements made at different times, particularly results relating to the same regions of the nebula, are compared. It is shown that during the period 1954–1962 the polarization of the Crab Nebula significantly decreased. (W.D.M.)

12516 CONDITIONS FOR THE FORMATION OF STEADY-STATE SYSTEMS AS A RESULT OF INSTABILITY. Chumak, O. V. (Astrophysical Inst., Alma-Ata, USSR). Astrophysics (Engl. Transl.); 3: 229-30(Winter 1967).

Translated from Astrofizika; 3: 493-6(1967).

It is shown that the necessary condition for a steady-state system to be produced in a homogeneous stellar medium as a result of instability is that the density of the region having the critical diameter should exceed the average density by a factor of 2.48. (auth)

12517 RADIUS OF NEUTRON STARS. Vartanyan, Yu. L. (Byurakan Astrophysical Observatory, USSR). Astrophysics (Engl. Transl.); 3: 231-3(Winter 1967).

Translated from Astrofizika; 3: 497-502(1967).

It is shown that the presence of a neutron core in superdense degenerate gaseous masses leads to a strong swelling of the shell consisting of degenerate electrons and atomic nuclei. (auth)

12518 MODELS OF MASSIVE SUPERDENSE BODIES. Saakyan, G. S.; Vartanyan, Yu. L. (Byurakan Astrophysical Observatory, USSR). Astrophysics (Engl. Transl.); 3: 234-6 (Winter 1967).

Translated from Astrofizika; 3: 503-9(1967).

A model of a massive superdense body is considered and it is shown that when the initial conditions for the components of the magnetic tensor are suitably chosen, a celestial body will have an anomalous mass defect, and hence will be unstable with respect to transition to a diffuse state whatever the form of the initial density distribution. (auth)

12519 NATURE OF AR ANDROMEDAE. Markaryan, B. E. (Byurakan Astrophysical Observatory, USSR). Astrophysics (Engl. Transl.); 3: 237-41(Winter 1967).

Translated from Astrofizika; 3: 511-18(1967).

Results are reported of direct and spectral observations of AR Andromedae, which suggest that it is a variable of the U Geminorum type and not of the Mira Ceti type, as has been accepted so far. The amplitudes of the brightness peaks are of the order of 5m, and the cycle length is about 68 days. A relatively strong ultraviolet continuum is observed in the spectrum throughout the cycle. Emission lines are observed after an appreciable reduction in the light and at minimum phase. (auth)

12520 TIME-DEPENDENT DIFFUSION OF RADIATION IN STELLAR ATMOSPHERES. Leonov, V. V. (Leningrad State Univ.). Astrophysics (Engl. Transl.); 3: 210-14(Winter 1967).

Translated from Astrofizika; 3: 447-58(1967).

The scattering of light in a one-dimensional semi-infinite medium with isotropic scattering is considered. The mean lifetime of a photon in the absorbed state is assumed to be a function of the optical depth. Exact and asymptotic expressions for the probability of escape and the probability of reflection of a photon from the medium are derived. The results are applied to the theory of novas. (auth)

12521 TRANSFER OF RESONANCE RADIATION IN A HALF-SPACE. Abramov, Yu. Yu.; Dykhne, A. M.; Napartovich, A. P. (Moscow Physical-Technical Inst.). Astrophysics (Engl. Transl.); 3: 215-23(Winter 1967).

Translated from Astrofizika; 3: 459-79(1967).

The Wiener–Hopf method is used to solve the problem of transfer of resonance radiation using the complete frequency redistribution approximation. Nonresonance processes such as photon absorption and quenching of excited atoms are taken into account. The method leads uniquely to both well-known and new results. Asymptotic expressions for the density of excited atoms are derived in an explicit form for an arbitrary line shape. The effect of frequency redistribution on the solutions is discussed. Wherever possible a physical interpretation of the results is given. (auth)

12522 SOME FUNCTIONS IN THE THEORY OF LIGHT SCATTERING. Sobolev, V. V. (Leningrad State Univ). Astrophysics (Engl. Transl.); 3: 205-9(Winter 1967).

Translated from Astrofizika; 3: 433-45(1967).

Equations containing the quantity λ as the independent variable are used to solve different problems in the theory of multiple scattering of light. An equation is given for deriving a number of formulas for the fundamental functions of the theory, some of which were obtained earlier, while others are new. The moments of the functions $\varphi(\eta)$, $\Phi(\tau)$, and $q(\infty) - q(\tau)$ are expressed in terms of the moments of the function $f(\xi)$. (auth)

12523 STELLAR ROTATION: THE ANOMALOUS RESULT OF ROXBURGH, GRIFFITH, AND SWEET. Sanderson, A. D.; Smith, R. Connon; Hazlehurst, J. (Univ. of Sussex, Eng.). Astrophys. J.; 159: L69-71(Jan 1970).

Comparison of the luminosity changes in rotating stars predicted by various authors shows that one paper is anomalous. Examination of this paper reveals an internal inconsistency, and recalculation produces a significantly different result. The new result is consistent with other published models, as is a further result for a different opacity law. Many papers based on the old result now need revision. (auth)

12524 SILICON MONOXIDE BANDS IN SOME LOW-TEMPERATURE STARS. Fertel, Jeanne H. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 159: L7-8(Jan 1970).

Several bands which appear in the near-infrared spectra of cool stars may be due to SiO. (auth)

12525 SPECTRAL LINE FORMATION BY NONCOHERENT SCATTERING WITH A DIPOLE PHASE FUNCTION. Hummer, D. G. (Univ. of Colorado, Boulder. National Bureau of Standards, Boulder, Colo.). Astrophys. Lett.; 5: 1-4(Jan 1970).

Results are presented for lines formed by atoms that scatter photons with complete redistribution in frequency and a dipole (Rayleigh) phase function. For optical thicknesses on the order of unity the ratio of limb ($\mu \simeq 0.2$) to disk intensity for dipole scattering is about 5% larger than for isotropic scattering, at all frequencies. For larger optical thicknesses ($\gtrsim 10^2$), the limb-to-disk ratio is about 2% lower for dipole than for isotropic scattering within a Doppler halfwidth of the line center and unity in the line wings. Some quantitative information is given on the angular distribution of the radiation field. An exact relation between two moments of the radiation field at the surface of a semi-infinite, isothermal medium is presented. (auth)

12526 THE CARBON ISOTOPE RATIO IN SOME COOL CARBON STARS. II. Fujita, Yoshio; Tsuji, Takashi; Maehara, Hideo (Tokyo Univ.). Proc. Jap. Acad.; 45: 484-9(Jun 1969).

The problem of isotopes in stellar atmospheres as a key for understanding element synthesis in stars is considered on the basis of the Swan bands of $^{12}C/^{12}C$ and $^{12}C/^{13}C$ in cool carbon stars, and estimates made of the $^{12}C/^{13}C$ ratio from the relative shift of the empirical pseudo-curves of growth for $C^{12}N$ and $C^{13}N$. This method is a type of iso-intensities method and the effect of saturation can automatically be taken into account on purely empirical basis. One difficulty in this method, however, is that the result depends critically on excitation temperature, which is difficult to determine exactly. Results show that this difficulty is obviated by the use of lines of satellite branches in (2,0) band of the red system of $C^{12}N$. It is emphasized that the C^{12}/C^{13} ratio is almost independent not only of excitation temperature but also of stratification in stellar atmospheres, or more generally, of atmospheric structure, since the C^{12}/C^{13} ratio is essentially determined by the lines originating from (2,0) bands both in $C^{12}N$ and $C^{13}N$ and the excitation conditions are almost the same for both cases. Thus, determination of the C^{12}/C^{13} ratio on a purely empirical basis independent of the details of line formation is possible. Studies on 12 carbon stars indicated that the C^{12}/C^{13} ratio is generally larger than 20 if excitation temperatures are assumed as high as effective temperatures, and it approaches the terrestrial value of 90 if excitation temperatures are lower than effective temperatures. Only for exceptional cases, such as Y CV and RY Dra, was the possibility that the C^{12}/C^{13} ratio is <10 suggested. (BBB)

12527 OBSERVATIONS OF CHUADZE'S AND WILD'S SUPERNOVAE. Borzov, G. G.; Dibai, E. A.; Esipov, V. F.; Pronik, V. I. (Shternberg Astronomical Inst., Moscow. Crimean Astrophysical Observatory, USSR). Sov. Astron. AJ (Engl. Transl.); 13: 423-6(Nov-Dec 1969).

Translated from Astron. Zh.; 46: 540-3(May-June 1969).

Photometric and spectroscopic observations of Chuadze's and Wild's supernovae are reported. It is shown that Chuadze's supernova belongs to type I, while Wild's supernova appears to be a peculiar type I object. (auth)

12528 DETERMINATION OF THE SURFACE BRIGHTNESS OF GLOBULAR CLUSTERS WITH A CIRCULAR DIAPHRAGM AND A NARROW SLIT. Veltmann, U.-I. K. (Astrophysical Observatory, Tartu). Sov. Astron. AJ (Engl. Transl.); 13: 517-18(Nov-Dec 1969).

Translated from Astron. Zh.; 46: 655-7(May-June 1969).

Allowance is made for the shape and size of the photoelectric-photometer aperture in determining the surface-brightness distribution in globular clusters. New observational data are presented for the globular clusters M15 ("circular" surface brightness on a linear scale) and M3 ("slit" surface brightness on a logarithmic scale). (auth)

12529 ACCELERATION OF THE GALACTIC MOTION OF STARS. Brazhnikova, E. F.; Dagaev, M. M.; Radzievskii, V. V. (Lenin Teachers' Coll., Moscow. Gorky Teachers' Coll., USSR). Sov. Astron. AJ (Engl. Transl.); 13: 480-4(Nov-Dec 1969).

Translated from Astron. Zh.; 46: 610-15(May-June 1969).

An equation is derived enabling one to calculate the photogravitational apex acceleration of a hot star from its brightness differences Δm in the apex and antapex directions. If the density of the dust medium is $\approx 10^{-25}$ g/cm^3 the value of the "apical force" for B stars would agree with Agekyan's estimate. The principal component of the apical force has a constant magnitude and a direction corresponding to the direction of motion of the star at perigalacticum. This component is responsible for a secular increase in the eccentricity of galactic orbits and in the stellar velocity dispersion. The variation in the velocity dispersion provides an estimate of 10^8 yr for the time required for an average star to evolve from the B0-B5 group to the B6-A2 group. (auth)

12530 REDDENING LINES IN THE UBV SYSTEM FOR TYPE G8-K0 GIANTS. Vasilevskii, A. E. (Gorky State Univ.). Sov. Astron. AJ (Engl. Transl.); 13: 485-7(Nov-Dec 1969).

Translated from Astron. Zh.; 46: 616-19(May-June 1969).

The slopes of the reddening lines are determined for giants of spectral types G8 III, K0 III, and K0 II from photometric data for stars in open clusters. A comparison of the results with the findings of Azhusenis and Straizhis (1966) indicates good agreement. It is concluded that these authors' reddening-line slopes are applicable for practical determinations of the color excesses of late-type stars. (auth)

12531 HYDRODYNAMICAL THEORY OF STELLAR ROTATION. I. ROTATION OF STARS IN THE GRAVITATIONAL-CONTRACTION PHASE. Porfir'ev, V. V. (Kiev Astronomical Observatory). Sov. Astron. AJ (Engl. Transl.); 13: 442-9 (Nov-Dec 1969).

Translated from Astron. Zh.; 46: 560-9(May-June 1969).

A discussion is given of the mass-loss process during the gravitational-contraction phase and of the process of variations in the rotation law as a star passes from the contraction phase to the main sequence. Some numerical estimates are made. It is shown that if a magnetic field is absent the loss of mass during the contraction phase can be quite large; the distribution of angular velocity with respect to spectral type cannot otherwise be explained. The variation in the rotation law with transition to the main sequence is considered. Two cases are treated: a) the angular momentum of each individual particle is conserved; b) a more or less complete redistribution of angular momentum takes place. Since there is no reason to expect the rotation during the gravitational-contraction phase to differ greatly from rigid rotation, the formation of a binary system through rotational fission is shown not to be possible. It is also shown that since meridional circulation may be expected to occur in massive stars, intensive mass loss may take place from such stars as they approach the main sequence, and gaseous circumstellar envelopes may be formed. (auth)

12532 ANISOTROPIC SCATTERING OF LIGHT IN A SEMI-INFINITE ATMOSPHERE. III. Sobolev, V. V. (Leningrad State Univ.). Sov. Astron. AJ (Engl. Transl.); 13: 403-10(Nov-Dec 1969).

Translated from Astron. Zh.; 46: 512-23(May-June 1969).

Scattering of light in an atmosphere illuminated by parallel rays is considered. The intensity of the diffuse radiation at an arbitrary optical depth τ is found. The phase function is expanded in a series in Legendre polynomials and the source function in a series in the cosines of angles which are multiples of the azimuth. Each coefficient of the latter series, $B^m(\tau,\eta,\xi)$, which depends on three variables, is expressed in terms of the function $\Phi^m(\tau)$, which only depends on τ. For the determination of the function $\Phi^m(\tau)$ an integral equation is obtained by means of which it is expressed in terms of the function $\Phi^m(\tau)$, which only depends on τ. For the determination of the function $\Phi^m(\tau)$ an integral equation is obtained by means of which it is expressed in terms of Chandrasekhar's function $H^m(\eta)$. A new method is proposed for expressing the functions $\varphi_i^m(\eta)$ in terms of the function $H^m(\eta)$. The case of a two-term phase function is considered as an example. (auth)

12533 HEAVY ELEMENTS IN 73 DRACONIS. Jaschek, M.; Malaroda, S. (Astronomical Observatory, La Plata). Nature (London); 225: 246-7(17 Jan 1970).

It is stated that the spectrum of the peculiar A-type star 73 Dra is atypical in that several of its anomalies are not shared with the two other Cr-Eu-Sr stars (HR 710 and HD 216533) that have been analyzed. From an examination of plates taken in 1958, covering the wavelength region 3700 to 4700 Å, it was found that 73 Dra shows the gross characteristics of an object belonging to the Cr-Eu-Sr group, and a strengthening of all iron-peak elements (such as Cr, Mn, Fe, Co, and Ni) and of some heavier elements like Sr. Two features, however, are not shared by the other objects of the Cr-Eu-Sr group, the first being the presence of very heavy elements (Os, Pt, Au, and U) and the second the presence of molecular compounds. The identification of Os, U, and Pt is regarded as certain; Au is probable but not certain. The importance of these findings is that heavy elements such as Ir (not found), Au, and U are produced only by the so-called processes of nucleo-

synthesis (neutron captures on a short time scale). A difficulty which arises in connection with the complex problem of Ap stars, posed by the presence of these elements, is briefly discussed. With regard to the presence of molecular compounds, many lines were found belonging to the transitions of the CN molecule, and there were several lines corresponding to the CH molecule. (UK)

12534 EJECTION OF COMPANION OBJECTS BY SUPERNOVAE. Colgate, S. A. (New Mexico Inst. of Mining and Tech., Socorro). Nature (London); 225: 247-8(17 Jan 1970).

It is stated that it is possible that supernovae occur in conjunction with either a satellite planet or binary star. Assuming that neutron stars are the result of supernovae explosions, the question arises of under what conditions could a planet or star survive such a nearby explosion? In the case of the Crab pulsar the existence of a planet has been suggested to explain a residual oscillation of period 1 to 1.5 months. Among simplifying assumptions that can be made are that the time of mass ejection is small compared with the orbit period, and that the mass of the second star or planet is smaller than that of the pre-supernova star. The first simplification is based on the notion that the ejection velocity of the major fraction of the matter from a supernova will be comparable with or larger than its initial escape velocity from the pre-supernova star; and because the binary member is necessarily at a larger radius, its orbital velocity will be less than the average ejection velocity. The second assumption is obvious for a planet, but is also qualitatively true for any likely binary star companion. If the passive companion were of larger mass than the pre-supernova star it would have evolved faster and would therefore more likely be the supernova itself. The fractional mass ejection by supernovae is not known. For thermonuclear supernova models, no remnant star remains. On the other hand, models of neutron star supernovae predict fractional mass ejections depending on the mass and structure of the initial star as well as on hydrodynamic details and transport processes. All such models, however, predict a small fractional mass ejection for bodies slightly more massive than the Chandrasekhar limit and are self-consistent in that the mass of the remnant neutron star does not exceed current stability limits. The question arises in what circumstances would a small companion main sequence star or planet remain bound? The hydrodynamic calculations of supernova explosions, whether thermonuclear or neutron star, are discussed. Amongst conclusions reached are that a binary star could survive with a final period as small as one month, but that any surviving planet would be likely to have a period of at least two months. (UK)

12535 DIFFICULTIES WITH FUSION CATALYSIS BY QUARKS. Salpeter, E. E. (Cornell Univ., Ithaca, N. Y.). Nature (London); 225: 165-6(10 Jan 1970).

Reference is made to Libby and Thomas (Nature 222, 1238 (1969)) who consider the effects on the production of stellar energy which arise if stable quarks are present inside main-sequence stars such as the Sun, and who state that some negatively charged quarks, if stable, could form "triatomic molecules" with pairs of nuclei and in this way catalyse fusion reactions between these nuclei. The present author re-examines the stability of such "molecules" and shows that binding to medium-heavy nuclei acts as a "catalytic prism" which withdraws the quarks from circulation. It is concluded that quarks, even if present in the interior of stars, could not appreciably affect energy production in the Sun and other stars. (UK)

12536 THE FORMATION AND GROWTH OF CARBON PARTICLES IN THE ATMOSPHERES OF MIRA VARIABLES. Fix, John D. (Indiana Univ., Bloomington). Mon. Notic. Roy. Astron. Soc.; 146: 51-5(1969).

In light of recent evidence that the oxygen to carbon ratio in Mira variables may be only slightly greater than 1.0, molecular dissociative equilibrium calculations are made using an O/C ratio of 1.03, O/H ratio of 10^{-4} and Si/H ratio of 4×10^{-5} to determine the region of the P, T plane in which carbon is supersaturated and particle formation is possible. A system of equations describing the formation and growth of carbon particles throughout the temperature cycle of a variable star is solved for a gas undergoing temperature variations characteristic of those occurring in the atmospheres of Mira variables. The results show that a large number of extremely small particles will form and that the extinction due to these particles is several orders of magnitude greater than the expected atomic and molecular extinction. (auth) (UK)

12537 THE FORMATION AND GROWTH OF CARBON PARTICLES IN THE ATMOSPHERES OF COOL CARBON STARS. Fix, John D. (Indiana Univ., Bloomington). Mon. Notic. Roy. Astron. Soc.; 146: 37-49(1969).

A system of equations is developed which describes the formation and growth of solid particles in an adiabatic gas undergoing sinusoidal time variations of temperature. The system of equations is solved throughout a cycle of temperature variation for a gas having an initial temperature, pressure, and composition representative of the atmosphere of a cool carbon star and having a period and amplitude of temperature variation typical of long-period variables. The results show that the particles form and grow to nearly their maximum size during a relatively small fraction of the period of temperature variation. The particles attain a maximum mean particle size of about 0.2 microns. The extinction due to the particles is calculated and found to be several orders of magnitude greater than the expected atomic and molecular extinction. (auth) (UK)

12538 PRODUCTION OF PROTON-RICH HEAVY SHIELDED ELEMENTS IN THE STARS. Agnese, A.; La Camera, M.; Wataghin, A. (Univ., Genoa, Italy). Mon. Notic. Roy. Astron. Soc.; 146: 57-62(1969).

The role of the isobar chain $s \rightleftharpoons i_{sp} \rightleftharpoons p$ in the explanation of the observed abundances of the proton-rich heavy shielded elements in the stars has been studied. The proton elements reviewed are: ^{164}Er, ^{74}Se, ^{84}Sr, ^{102}Pd, ^{108}Cd, ^{114}Sn, ^{126}Xe, ^{180}W, ^{196}Hg. The mechanism analyzed is found to be efficient for the production in the required abundance for: ^{164}Er, ^{74}Se, ^{108}Cd, ^{114}Sn, ^{126}Xe, ^{180}W, ^{196}Hg, and partially efficient for ^{102}Pd. (auth) (UK)

12539 THE ANALYSIS OF THE LOW-GRAVITY HALO STAR HD 214539. Przybylski, A. (Australian National Univ., Canberra). Mon. Notic. Roy. Astron. Soc.; 146: 71-90(1969).

In a coarse analysis the high-velocity metal-poor Ao Ib star HD 214539 was compared with two normal giants η Leo and 13 Mon. It has been found that: (1) with a high degree of probability HD 214539 has a normal helium content; (2) silicon is under-abundant by a surprisingly low factor of 2 only; magnesium, which like silicon, is formed in the helium-burning process, is under-abundant by a higher factor of 10; (3) the iron group is deficient by a factor varying between 13 and 30; and (4) sodium (formed through the s- and p-processes) is under-abundant by a factor of 30. (auth) (UK)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstract 12600.

12540 (AD-695838) RADIO AND OPTICAL EMISSION FROM HIGH-ENERGY COSMIC RAYS. Final Scientific Report, January 1, 1967-August 31, 1969. Porter, Neil A. (University Coll., Dublin (Ireland). Dept. of Physics). 17 Sep 1969. 113p. (AFOSR-69-2684-TR). CFSTI.

A fast optical Cherenkov system was used to search for gamma-rays from pulsars in the energy region 1000 to 10,000 Gev. Analysis was carried out for both a continuous flux and a pulsed flux at the pulsar frequency. Several experiments were carried out on radio pulses emitted by extensive air showers in the atmosphere. A long distance coincidence experiment, a correlation between radio pulses and particles, and between radio pulses and optical Cherenkov pulses were carried out at 44 and 70 MHz. Pulses in the uhf band at 520 to 550 MHz were observed in coincidence with particles. (auth)(USGRDR)

12541 MAGNETORELATIVISTIC MODEL OF A PULSAR PULSE. Kaplan, S. A.; Eidman, V. Ya. JETP Lett. (USSR) (Engl. Transl.); 10: 203-6(5 Oct 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu; 10: 320-3(5 Oct 1969).

A pulsar model is proposed which assumes that the pulsar is a neutron star with a dipole (or more complicated) magnetic field, rotating or oscillating in such a way that the pulsar surface regions containing the magnetic fields move with relativistic velocities. Such a model cannot be rigorously justified at present, but some qualitative considerations in its favor are advanced. (W.D.M.)

12542 ABSOLUTE SPECTRAL ENERGY DISTRIBUTION OF QUASI-STELLAR OBJECTS FROM 0.3 TO 2.2 MICRONS. Oke, J. B (Mount Wilson Observatory, Pasadena, Calif. Palomar Observatory, Pasadena, Calif. Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena); Neugebauer, G.; Becklin, E. E. Astrophys. J.; 159: 341-55(Jan 1970).

The absolute spectral energy distribution from 0.32 to 2.2 μ was obtained for twenty-eight quasi-stellar sources. Photometry at 2.2 μ was obtained for an additional fifteen objects. The data show that the continua over this wavelength range generally can be described with a power-law spectrum; the index varies from -0.2 to -1.6, with the entire range being populated. For quasi-stellar objects which are known to have large-amplitude varia-

tions in visual magnitude, the energy distributions remain sensibly unchanged during the variations. No characteristic of the energy distribution in the observed range of wavelengths which distinguishes between radio-quiet and radio-active quasi-stellar objects is found. The near constancy of the observed ratio of the line intensities of Lα to the C IV line can be interpreted as implying an electron temperature of 20000°K. The range of equivalent widths of both (Hα + [N II]) and Lα is small. The ratio of the number of photons in the Lyman continuum with respect to the number in the Lα line is not consistent with radiative recombination from an opaque source. (auth)

12543 STOKES PARAMETERS FOR OH SOURCES. Coles, W. A.; Rumsey, V. H. (Univ. of California, San Diego). Astrophys. J.; 159: 247-61(Jan 1970).

Stokes parameters for certain of the 1665- and 1667-MHz OH emission lines of the sources in W3, W22, W24B2, W33, W43, W49, Ori A, Cas A, and NGC 6334; and for the 1612- and 1720-MHz lines of W28, G5.9−04, W43, W44, and W51 were measured during 1968 February and May. At 1665 MHz but not at 1667 MHz, W33 showed strong time variation from February to May and during a 10-day period in May. There is evidence of time variability in W3 at 1665 MHz. Emission at 1667 MHz from a dark cloud at $l = 168.74°$, $b = -15.50°$ showed less than 10% polarization. No polarization was detected in any absorption feature, within an accuracy depending on the source strength: 2% accuracy for Cassiopeia is typical. (auth)

12544 TIME DELAYS OF ELECTROMAGNETIC PULSES DUE TO MOLECULAR RESONANCES IN THE ATMOSPHERE AND THE INTERSTELLAR MEDIUM. Trizna, Dennis B.; Weber, Thomas A. (Ames Lab., Iowa). Astrophys. J.; 159: 309-17(Jan 1970).

Pulsed radio signals in a medium will travel at less than the speed of light in a vacuum when the main frequency components of the pulse lie in a region of anomalous dispersion. Time delays due to anomalous dispersion by molecular radiofrequency resonances for signals propagating through the Earth's atmosphere and the interstellar medium are estimated. For resonances below microwave frequencies, it appears that nominal time delays may occur for little measurable absorption. This effect may allow identification, and perhaps column-density estimates, of neutral constituents of these media. It is also indicated how it may be pertinent in radar observations of other planets. (auth)

12545 MOTIONS OF HIGH-LATITUDE HYDROGEN CLOUDS. Mast, J. W.; Goldstein, S. J. Jr. (Univ. of Virginia, Charlottesville). Astrophys. J.; 159: 319-24(Jan 1970).

The solar motion with respect to 268 well-resolved (in velocity) 21-cm hydrogen clouds with galactic latitudes numerically greater than 20° and declinations greater than −40° was obtained. The result is a velocity of $21.2° \pm 0.9°$ km sec^{-1} toward $l = 52.5° \pm 2.9°$ $b = +21.3° \pm 2.6°$, where the uncertainties are standard errors. The mean distance times the galactic-rotation constant is 6.8 ± 2.1 km sec^{-1}, and the apparent longitude of the center of rotation is $346.5° \pm 4.0°$. The residual radial velocities are well fitted by an exponential distribution function of the form $P(v) = (2\eta)^{-1} \exp(-|v|/\eta)$, where the maximum-likelihood principle gives 5.0 km sec^{-1} for η. The average distance of hydrogen clouds in the latitude range 20 to 40° does not follow a cosecant law, but rather is approximately constant. (auth)

12546 ON THE MOTION OF CURRENT SHEETS, AND THE RADIO, OPTICAL, AND X-RAY EMISSION FROM PULSARS. Lerche, I. (Univ. of Chicago). Contract F-19628-69-C-0041. Astrophys. J.; 159: 229-37(Jan 1970).

It is suggested that an oscillating current sheet is the source of pulsar radiation produced over a broad band of high frequencies (~10^8 to 10^{18} c/s). The differential spectrum of the emitted radiation varies as $f^{-\frac{1}{2}}$, where f is the frequency. The radiation extends through the radio, optical, and x-ray regions. The efficiency of the radiation mechanism is so high that the oscillation energy goes mainly into radiation in each cycle of the oscillation. Applications to pulsars suggest that this parametric conversion mechanism may be responsible for the broad-band spectrum observed in, say, pulsar NP 0532. (auth)

12547 SOFT X-RAY SPECTRA OF THREE COSMIC SOURCES AND SIMULTANEOUS OPTICAL OBSERVATIONS OF SCO XR-1. Grader, R. J. (Univ. of California, Berkeley); Hill, R. W.; Seward, F. D.; Hiltner, W. A. Astrophys. J.; 159: 201-14(Jan 1970).

New x-ray spectra were obtained for Sco XR-1, the Crab Nebula, and a low-energy source currently designated Vela XR-2. The range of photon energies covered was ~150 eV to 10 keV. The Sco XR-1 data are interpreted as thin-source, thermal bremsstrahlung with absorption in cool material. The new data are compared with previous low-energy spectra of Sco XR-1, and this source is shown to be probably variable in the soft x-ray region. The spectrum of the Crab Nebula shows absorption in cool material at low energies. Vela XR-2 is the most intense source of the three at photon energies ≤0.5 keV. (auth)

12548 PREDICTED PARAMETERS OF SUPERNOVA PULSARS. Large, M. I. (Univ. of Sydney). Astrophys. Lett.; 5: 11-15(Jan 1970).

Thirty-five known or suspected supernova remnants are selected as promising candidates for the detection of an associated pulsar, and tentative predictions of the pulsar parameters are given. (auth)

12549 SHORT-TERM PULSAR ENERGY FLUCTUATIONS. Jones, B.; Wielebinski, R. (Univ. of Sydney). Astrophys. Lett.; 5: 17-20(Jan 1970).

Observations of a number of pulsars were analyzed so as to compare the statistics of their short term pulse energy fluctuations. Pulse amplitude histograms and power spectra of the fluctuations are presented for the pulsars PSR 0833-45, PSR 1451-68, PSR 2045-16, and PSR 1749-28 at a number of frequencies. (auth)

12550 ALIGNMENT OF OBLIQUE ROTATORS. Michel, F. Curtis; Goldwire, H. C.Jr. (Rice Univ., Houston, Tex.). Astrophys. Lett.; 5: 21-4(Jan 1970).

Pulsars may be slowed down by radiation field torques. The torques on a rigid uniformly magnetized sphere rotating in a vacuum were examined and an accompanying torque was found that aligns the magnetic moment with the spin axis. The general implication of such a model, if applicable to pulsars, is that most pulsars would have to have been formed either with periods not too different from what are now observed or with magnetic moments almost precisely orthogonal to the spin axis. Alternatively, neutral sheet formation in the pulsar magnetosphere, or other plasma effects, may suppress the alignment torque. (auth)

12551 COMPTON-SYNCHROTRON RADIATION FROM PULSARS. Apparao, Krishna M. V. (Smithsonian Astrophysical Observatory, Cambridge, Mass.); Hoffman, Jeffrey. Astrophys. Lett.; 5: 25-8(Jan 1970).

Compton scattering of synchrotron radiation from its parent electrons in pulsars is discussed, and Compton-synchrotron radiation from the pulsar NP 0532 is calculated. Comparison with observations leads to a lower limit of a few times 10^3 gauss for the magnetic field near the radiation-emitting region of the pulsar. Such considerations indicate that the radiation-emitting region is most likely near the "speed-of-light circle" of the pulsar. (auth)

12552 PULSATION DAMPING BY THE NONLEPTONIC WEAK INTERACTION IN HYPERON STARS. Jones, P. B. (Oxford Univ.). Astrophys. Lett.; 5: 33-6(Jan 1970).

In a hyperon star, departures from equilibrium neutron and hyperon number densities are restored by the nonleptonic weak interaction, with a relaxation time of the order of the expected period of pulsation. This relaxation time and the large neutron-hyperon mass difference cause pulsation damping in times comparable with those for gravitational radiation. (auth)

12553 PULSAR PLANETARY SYSTEMS. Michel, F. Curtis (Rice Univ., Houston, Tex.). Astrophys. J.; 159: L25-8(Jan 1970).

It is shown that any planets surrounding a pulsar should be in eccentric orbits and that one effect of such planets would be to give apparently discontinuous changes in the frequency of the pulsar, as have been observed for NP 0532 and PSR 0833. (auth)

12554 POSSIBLE EFFECTS OF SCATTERING OF PULSAR RADIATION. Code, Arthur D. (Univ. of Wisconsin, Madison. Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J.; 159: L29-34(Jan 1970).

The modification of the light curve of a pulsar by a scattering atmosphere is investigated from the point of view of the time-dependent equation of transfer. The pulses are asymmetrically broadened as the contribution from diffusely scattered radiation is increased. It is suggested that a pulsar may possess an envelope of sufficient density that the free−free opacity is important for frequencies less than about 100 MHz. In this case the pulse widths would increase with decreasing frequency, and at lower frequencies the pulsar would no longer exhibit the pulse characteristic. (auth)

12555 TIME-OF-ARRIVAL OBSERVATIONS OF ELEVEN PULSARS. Reichley, P. E.; Downs, G. S.; Morris, G. A. (California Inst. of Tech., Pasadena). Astrophys. J.; 159: L35-40 (Jan 1970).

The analysis of high-precision time-of-arrival measurements has yielded the position, period, and first derivative of the period for ten pulsars and an improved period for one other. An upper bound was obtained for the second derivative of the period for six pulsars. (auth)

12556 SPECTRAL DATA ON SOME OHIO RADIO SOURCES. Kraus, J. D. (Ohio State Univ., Columbus); Andrew, B. H. Astrophys. J.; 159: L41-3(Jan 1970).

Flux densities are given for seventy-one sources in the frequency range 0.6 to 10.6 GHz. Most of the sources have been discovered in the Ohio survey, and the majority have low spectral indices or peaked spectra. (auth)

12557 RADIO SOURCES WITH FLAT SPECTRA. Andrew, B. H. (National Research Council of Canada, Ottawa); Kraus, J. D. Astrophys. J.; 159: L45-9(Jan 1970).

The spectra of sixty-three radio sources discovered in surveys conducted at 1.4 GHz are studied in the frequency range 0.6 to 10.6 GHz. Many of the spectra are flat at high frequencies, and very few show evidence of having more than one spectral component. It is argued that a large fraction of the population of sources with flat high-frequency spectra are optically thin sources with low values of the electron-energy distribution index γ. (auth)

12558 SIMULTANEOUS X-RAY AND OPTICAL OBSERVATIONS OF SCO X-1 FLARES. Hudson, Hugh S.; Peterson, Laurence E.; Schwartz, Daniel A. (Univ. of California, San Diego). Astrophys. J.; 159: L51-5(Jan 1970).

The x-ray telescope on the Orbiting Solar Observatory III has made extensive observations of Sco X-1 during 1967 May and June. Two occasions of x-ray flaring, at 07h26m and 09h10m U.T. on 1967 June 3, happened to coincide with optical observations of the same phenomena, thus proving the connection between optical and x-ray flares on Sco X-1. The x-ray enhancements amounted to about a factor of 2 over the quiescent emission in the energy range 7.7 to 12.5 keV. (auth)

12559 OBSERVATIONS OF THE DEVELOPMENT AND DISAPPEARANCE OF THE X-RAY SOURCE CENTAURUS XR-4. Evans, W. D.; Belian, R. D.; Conner, J. P. (Los Alamos Scientific Lab., N. Mex.). Astrophys. J.; 159: L57-60(Jan 1970).

The intensity of 3- to 12-keV photons from the cosmic x-ray source that appeared in 1969 between July 6 and July 9 at α = 14h56m, $\sigma = -32°15'$, herein called Cen XR-4, has decreased to less than 0.5% of its maximum value; and since September 24 the source has not been detectable by the Vela satellite instruments that first observed it. Initially the decay of this source was similar to that observed for Cen XR-2. The overall time history up to the present is surprisingly similar to light curves for novae of the DQ Herculis type. After an initial decline in spectral hardness in the first week, no further marked changes of hardness have been detected in the observational data. (auth)

12560 COHERENT SYNCHROTRON EMISSION IN THE CRAB NEBULA. Caroff, L. J.; Scargle, J. D. (Ames Research Center, Moffett Field, Calif.). Nature (London); 225: 168(10 Jan 1970).

It is stated that recent analyses of the electrodynamics of the plasma surrounding a rotating magnetic neutron star provide plausible mechanisms for the acceleration of high-energy particles in the Crab Nebula. Some implications of these models are discussed. An explanation is proposed for the small diameter low-frequency radio source which probably lies near the centre of the Crab and which may be associated with the pulsar, and it is suggested that the high brightness temperatures associated with this source may result from coherent synchrotron emission associated with phase coherence of the electron gyro-motion. (UK)

12561 AGE OF PULSAR PSR 0833-45. Shklovskii, I. S. (Inst. of Space Research, Moscow). Nature (London); 225: 252-3(17 Jan 1970).

The age of this pulsar as determined from its period and the rate of increase of this period is ≈12,000 year. The pulsar has been identified with the radio nebula Vela X, which is a typical remnant of a type II supernova, such as the Cygnus loop and IC 443, for example. The age of the Cygnus Loop lies between 60,000 and 100,000 yr., and from the relationship $t_{Vela} \simeq \frac{1}{2} t_{Cyg}$ it is concluded that the age of Vela X is in the range 30,000 to 50,000 yr., which is several times larger than the age of pulsar PSR 0833-45, which is nevertheless evidently connected genetically with this nebula. Possible explanations are offered. (UK)

12562 NATURE OF EMISSION FROM PULSAR NP 0532. Shklovskii, I. S. (Inst. of Space Research, Moscow). Nature (London); 225: 251-2(17 Jan 1970).

This pulsar, situated in the Crab Nebula, is the only object of its kind from which optical and x radiation have been observed, and it has been proposed that this radiation can be explained by a synchrotron mechanism in the dipole magnetic field of a rotating neutron star. Some evidence is discussed, supporting this mechanism, which is stated to make possible a qualitative development of the theory of nonthermal radiation from the pulsar. According to observations in the near-infrared region, the spectral flux density from the pulsar for $\nu < \nu_m = 7.5 \times 10^{14}$ Hz decreases with the frequency ν, and it is suggested that this can only be explained by synchrotron reabsorption. (UK)

12563 SHORT DURATION PULSATIONS OF CP 0808 AND MAIN FEATURES OF ITS RADIO EMISSION IN THE METRE BAND. Vitkevich, V. V.; Shitov, Yu. P. (Lebedev Inst. of Physics, Moscow). Nature (London); 225: 248-51(17 Jan 1970).

Some observations of this pulsar made in Nov. to Dec. 1968 are described, using the E–W line of the Poushchino cross-type DKP-1000 radiotelescope at 60 to 110 MHz. It was established that the pulsar shows short-duration subpulses, details of which are reported. Pulses in the 60 to 110 MHz band consisted of several subpulses spaced, on the average, at 53.6 ms, and an analysis of the positions of the subpulses indicated that CP 0808 has a second-class periodic pulsation with a mean period value of 0.053642 ± 0.000002 sec. The subpulses of the group consisting, on the average, of 11 pulses follow each other with a mean period of 1.2874 sec. The subpulses of this group then gradually disappear, while the subpulses of another group, shifted from the first by 53.6 ms, from the next sequence of pulses. The picture is then repeated. It is noted that the second-class period of CP 0808 exceeds the permissible periods for pulsating neutron stars, providing evidence that this pulsar (and probably all other pulsars) is not a neutron star in the classical sense. The mean shape of the pattern of radio emission was found by plotting a histogram of the amplitudes of the subpulses against their position in time; it shows sharp boundaries and contains several characteristic maxima, with a broad minimum in the middle of the pattern. The width of the pattern remained constant for some days. The pattern width was wavelength-dependent, which forms a powerful argument in favour of a coherent emission mechanism from individual cells that make up the emitting region of the pulsar. The wavelength dependence of pattern width explains why CP 0808 often emits three subpulses at 60 MHz, yet only one, or rarely two, at 110 MHz. At metre wavelengths, CP 0808 shows fine structure in the subpulse radio spectrum that is regularly repeated. The measurements showed that in the 60- to 110-MHz band there is, on the average, an accurate square dependence of subpulse delay time on wavelength. The integrated electron density is 5.757 ± 0.002 pc/cm^3. (UK)

12564 PERCENTAGE NUMBER OF NONTHERMAL SOURCES IN THE NORTHERN AND SOUTHERN HALVES OF THE GALAXY. Altenhoff, W. G.; Wilson, T. L. (National Radio Astronomy Observatory, Green Bank, W. Va.). Nature (London); 225: 245-6 (17 Jan 1970).

Nonthermal sources show no radio recombination lines and have steep spectral indices, and it is suggested that such sources are galactic supernova remnants. Two recent and fairly complete radio recombination line surveys at 5,000 MHz are described (observing the transition from the 110th to the 109th level of hydrogen using the NRAO 140-ft radio telescope between l = 348 and 85° and the 210-ft telescope between l = 290 and 345°). The latter southern survey showed 84 sources of which eight had no line, while between 15 and 70° the northern survey showed 38 sources with ten showing no line. These estimates indicate 9.5% in the south and 26.3% in the north for the percentages of sources with no H 109 α line present. Comparisons are made with continuum surveys. The discrepancy between northern and southern parts of the Galaxy may be due to three factors: (1) a large-scale asymmetry in the structure of the Galaxy, exhibited in the percentage number of supernova remnants: (2) incompleteness of one or both of the line surveys; and (3) different resolution and peak flux limits for line and continuum surveys. Asymmetry of the Galaxy is probably not large. Possibility (2) does not apply, since the surveys are known to be fairly complete. The third possibility is discussed, and it is concluded that the principal cause of the markedly different percentages is the different angular resolution of the telescopes. The surveys found a number of new nonthermal sources, which are interpreted as galactic supernova remnants because of their large angular size and high peak flux. (UK)

12565 FIVE NEW PULSARS. Vaughan, A. E.; Large, M. I. (Univ. of Sydney). Nature (London); 225: 167-8(10 Jan 1970).

It is stated that five new pulsars have been found in the course

of the search program at the Molonglo Radio Observatory; these are designated MP 0818, 1359, 1604, 1857, and 1944. It is very difficult, however, to measure the properties of these pulsars, which are weak and very erratic. (UK)

12566 A THEORY FOR THE FORMATION AND STABILITY OF THE JETS IN QUASARS AND RADIO-GALAXY NUCLEI. Bisnovatyi-Kogan, G. S.; Komberg, B. V.; Fridman, A. M. (Inst. of Applied Mathematics, Moscow. Inst. of Nuclear Physics, Novosibirsk, USSR). Sov. Astron. AJ (Engl. Transl.); 13: 369-73(Nov-Dec 1969).

Translated from Astron. Zh.; 46: 465-71(May-June 1969).

A plasma-stability mechanism is proposed to explain the basic features observed in the jets extending from radio-galaxy nuclei and quasars. The essential aspect of this mechanism is the relativistic electrons injected from the nucleus into a conducting medium will carry ions along with them so that the quasi-neutrality condition will be satisfied. The charge separation arising at the time of ejection of the electrons will lead to a build-up of longitudinal oscillations in the beam, forming a magnetic field about the axis of the jet. The pinch formed in this manner will be unstable against perturbations of the constriction type. The distance between constrictions is found to be of the same order as the thickness of the pinch. A detailed examination of the process of formation of a constriction and of each successive plasma condensation indicates that the directions of the currents in adjoining condensations will be opposite to each other. This circumstance, together with the equilibrium condition at the pinch boundary, can explain the observed sequence of changes by $\approx\pi/2$ in the polarization plane of adjoining condensations. The presence of a plateau in the electron velocity-distribution function, formed through beam instability, provides a natural explanation of the low-frequency "falloff" in the spectrum of certain radio sources. The period T of variation in the polarization plane and luminosity in individual condensations of a jet is predicted; for Virgo A the estimate is ≈100 yr. (auth)

12567 RECONSTRUCTION OF THE RADIO-BRIGHTNESS DISTRIBUTION OVER A SOURCE. Tikhonov, A. N.; Vitkevich, V. V.; Artyukh, V. S.; Glasko, V. B.; Goncharskii, A. V.; Yagola, A. G. (Lebedev Inst. of Physics, Moscow. Moscow State Univ.). Sov. Astron. AJ (Engl. Transl.); 13: 374-80(Nov-Dec 1969).

Translated from Astron. Zh.; 46: 472-80(May-June 1969).

An investigation was made of the efficiency of the method of regularization for reducing radio observations made with the east–west array of the wide-band cross-type DKR-1000 radio telescope of the Lebedev Physics Institute. (auth)

12568 THE INDUCED COMPTON EFFECT FOR ELECTROMAGNETIC AND PLASMA WAVES UNDER ASTROPHYSICAL CONDITIONS. Tsytovich, V. N.; Chikhachev, A. S. (Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.); 13: 385-95(Nov-Dec 1969).

Translated from Astron. Zh.; 46: 486-501(May-June 1969).

The effects are investigated of induced scattering by relativistic electrons, converting plasma waves into electromagnetic waves and electromagnetic into electromagnetic waves. It is shown that if the relativistic-electron density is high the induced effect can result in an efficient acceleration because of the simultaneous action of electromagnetic and plasma waves. The acceleration effect can grow in proportion to the square of the particle energy, and can compensate for the losses due to the inverse Compton effect. Under these conditions a self-consistent distribution of relativistic electrons and electromagnetic radiation will, if H = 0, yield a $1/\epsilon^{\gamma}$ spectrum for the relativistic electrons, with an exponent $\gamma = 3$. An equation is obtained for γ, and the dependence of γ on the ratio of the magnetic energy $H^2/8\pi$ to the plasma energy density is analyzed. The problems of the high-frequency radio emission of cosmic objects are discussed, and an explanation is given for their power-law spectrum. Problems concerning the radiation spectra of quasars and other new objects with strong radio emission are examined. (auth)

12569 GENERATION AND TRANSFER OF POLARIZED SYNCHROTRON RADIATION. Sazonov, V. N. (Lebedev Inst. of Physics, Moscow. Moscow Physicotechnical Inst.). Sov. Astron. AJ (Engl. Transl.); 13: 396-402(Nov-Dec 1969).

Translated from Astron. Zh.; 46: 502-11(May-June 1969).

Solutions of the transfer equation for the synchrotron radiation polarization tensor are investigated. Reabsorption of radiation by radiating relativistic electrons and the Faraday effect in a magnetoactive plasma are taken into account in this treatment. It is shown that synchrotron radiation can emerge almost completely circularly polarized from a source when the radiation is amplified (negative reabsorption). In the case of absorption of synchrotron radiation, by positive reabsorption, one must expect a rise in the degree of linear polarization with fall-off in frequency, if nonrelativistic plasma is present in sufficient concentration in the source. The oscillatory pattern of variation in the intensity of the linearly polarized component and of the position angle, as functions of optical thickness, is discussed. The effect of anisotropic angular distribution of electrons on the degree of circular polarization of the radiation, both in the case of spontaneous emission and in the case of emergence from a source, is discussed. The transfer equation is averaged in the case of a random magnetic field. (auth)

12570 SUPERNOVA REMNANTS AND HIDDEN PULSARS. Cavaliere, A. (Massachusetts Inst. of Tech., Cambridge. Laboratorio Gas Ionizzati, Rome); Pacini, F. Astrophys. J.; 159: L21-4(Jan 1970).

If a supernova remnant draws its energy from a rotating neutron star, the total luminosity should decrease about 4 times faster than the rotation period of the central star. Parameters for the pulsar in Cas A (if there is one) are derived as a function of the luminosity and luminosity change. The same considerations could have given the parameters of the neutron star in the Crab before the discovery of the pulsar NP 0531. Some general remarks are made concerning the coupling of the stellar rotation with the nebular remnant. (auth)

12571 MEASUREMENTS OF THE RIGHT ASCENSION OF THE CRAB NEBULA AT METER WAVELENGTHS. Matveenko, L. I.; Pynzar, A. V. (Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.); 13: 433-41(Nov-Dec 1969).

Translated from Astron. Zh.; 46: 550-9(May-June 1969).

The technique and results are described for measurements, made at 7.9-m wavelength, of the right ascension and flux density of the radio source in the Crab Nebula having small angular size. Its position relative to the center of the binary star is $\Delta\alpha = -0.04 \pm 0.38$s. An estimate is obtained for the spectrum of the source. The right ascension of the Crab Nebula has been measured at wavelengths of 3.5, 5, and 7.9 m, with the source 3C 123 adopted as a reference object. (auth)

Solar Phenomena

Refer also to abstracts 12659, 12667, and 12707.

12572 (N-70-12221) OGO 3 DATA ANALYSIS: DYNAMIC SPECTRA OF SOLAR BURSTS. Final Scientific Report. Graedel, Thomas E. (Michigan Univ., Ann Arbor. Dept. of Astronomy). [1968]. 74p. (NASA-CR-107031). CFSTI.

The computation of solar burst time profiles and dynamic spectra, utilizing a model of the form described, can produce theoretical values for Type-3 burst characteristics that agree quite well with observational values. The parameters used in the model can then be regarded as indicative of coronal physical conditions and of Type-3 solar burst radiation mechanisms. A high level of accuracy was obtained in matching observations, even though the model which was used did not treat the difficult plasma physics problems in a realistic way. The results presented refer to average Type-3 bursts. Any individual event is likely to result from an electron velocity spectrum that differs from the average, and may occur with a density enhancement differing from the model described. (auth) (STAR)

12573 SOLAR OBLATENESS AND THE GRAVITATIONAL QUADRUPOLE MOMENT. Dicke, R. H. (Palmer Physical Lab., Princeton, N. J.). Astrophys. J.; 159: 1-24(Jan 1970).

The connection between the oblateness and the gravitational quadrupole moment of the Sun is developed under the assumption of the absence of magnetic and velocity fields in the surface layers. This discussion is generalized to include also the effects of surface rotation for rotation on cylinders. The theory of the generation by surface fields of oblateness and equatorial temperature excess is developed and used to discuss the various attempts by Roxburgh, Cocke, Sturrock, and Gilvarry to account for the observed oblateness as an effect of surface fields only. The severe constraint on allowed surface fields introduced by the observed latitude independence of solar brightness is analyzed. It is concluded that an acceptable explanation of the solar oblateness, other than the effects of a gravitational quadrupole and surface rotation, has yet to be found. (auth)

12574 WHY ARE SUNSPOTS DARK AND FACULAE BRIGHT? Dicke, R. H. (Palmer Physical Lab., Princeton, N. J.). Astrophys. J.; 159: 25-38(Jan 1970).

It is shown that the darkening or brightening of a disturbed spot on the Sun's surface is uniquely determined by the abnormal stress distribution in the "seen layers" of the spot. The magnetic and velocity fields are the sources of the anomalous stress. A crude sunspot model based on the general theory is shown to give results in satisfactory agreement with the observations. (auth)

12575 ISOTOPES OF MAGNESIUM IN THE SUN. Branch, David (Univ. of Maryland, College Park). Astrophys. J.; 159: 39-49(Jan 1970).

Examination of the magnesium hydride $A^2\Pi - X^2\Sigma$ 0–0 band in high-dispersion sunspot spectrograms reveals that, in addition to strong absorption lines of ^{24}MgH, features due to ^{25}MgH and ^{26}MgH can be identified. The wavelengths of the isotopic lines are found to be in excellent agreement with predicted wavelengths. Coarse analysis indicates that in the sunspot region the isotopic ratios of magnesium, $^{24}Mg : ^{25}Mg : ^{26}Mg$, are nearer to 60 : 20 : 20 than to the terrestrial and meteoritic values of 79 : 10 : 11. Detailed analysis based on several different sunspot models, also yields isotopic ratios of approximately 60 : 20 : 20. Because of uncertainties involving sunspot models, continuum location, line blending, and scattering photospheric light, the conclusion is limited to the statement that the heavy isotopes of magnesium appear to be enhanced in the Sun relative to the Earth. Further study based upon photoelectric spectrophotometry and improved sunspot models is suggested. (auth)

12576 OCCURRENCE OF HIGH-ENERGY RELEASES DURING FLARES IN LOCALIZED AREAS OF AN ACTIVE CENTER AND TIME-ASSOCIATED CHANGES IN SPOT UMBRAE. McKenna-Lawlor, Susan M. P. (Univ. of Michigan, Ann Arbor). Astrophys. J.; 159: 51-9(Jan 1970).

Although many flares occurred in active center HAO-59Q during its fifth passage across the solar disk, July 7–21, 1959, it is shown that only two localized areas within this region were associated with the commencement of significant energy releases. The energy importance of individual optical brightenings has been gauged by the magnitude of time-associated single-frequency radio bursts. In certain cases, localized high-energy flaring appears to be followed by extensive low-energy flaring, and such events are here called "primary flares" and "secondary flares," respectively. The positions of persistent flare-sensitive regions, calcium plages, filaments, and spot umbrae in HAO-59Q have been compared with the daily magnetograms of this center of activity published by the Crimean Astrophysical Observatory for July 14–17, 1959. The flare-sensitive regions were located near filaments and adjacent to the two sides of the loci of zero longitudinal magnetic field strengths. The magnetograms closely reflect local daily changes in the sunspots; hence, any role played by flares of high energy in producing changes in the magnetic field cannot be deduced unambiguously from these records. It is shown that the parts of the chromosphere associated with high-energy flares were directly over areas of the photosphere which contained transient umbrae. Flares with high energy occurred in intervals within which such umbrae disappeared or diminished in area. A close association between localized, high-energy flaring and an underlying changing spot umbra may be a necessary condition for the generation of high-energy particles. (auth)

12577 THERMAL EMISSION OF THE F CORONA. Kaiser, C. B. (National Center for Atmospheric Research, Boulder, Colo.). Astrophys. J.; 159: 77-92(Jan 1970).

A model of the heliocentric dust cloud is constructed which allows for the variation of temperature with particle size and optical properties, and the thermal emission is computed. The results show that a stony dust material produces two emission peaks at near-infrared wavelengths. Comparison with recent observations at wavelength 2.2 μ indicates that there are two dust materials present near the Sun. The positions and radiance of the observed peaks allow an estimation of the properties of these materials and the size distribution and space density of the dust particles. The thermal emission predicted by the model is computed at longer wavelengths for comparison with future observations, and the variation with wavelength is found to reflect the reststrahlen band structure of the dust materials. (auth)

12578 ION-INDUCED CHANGES IN SIMULATED LUNAR ROCKS. Cruikshank, Dale P. (Lunar and Planetary Lab., Tucson, Ariz. Sternberg Astronomical Inst., Moscow). Icarus; 11: 145-54(Sep 1969).

To study the effects of the solar-wind flux on the infrared reflectivity of rocks and minerals on the Moon, a laboratory apparatus was constructed for irradiation of rock samples with an ion flux having the same energy as the ambient solar wind, but with 10^7 to 10^9 times the flux density. The infrared colorimetric profiles from 0.8 to 2.2 μ were measured for several natural and irradiated samples. Irradiated rocks became generally "redder" in the total wavelength region considered (the albedo curve is steepened toward the red), and the absorption bands attributed to Fe^{3+} were transformed into Fe^{2+} bands. The relationship of the visual darkening of the rocks on irradiation and the changes in iron absorption bands are discussed relative to the lunar surface. The problem of oil contamination in the ion system is discussed and it is concluded that in the present experiment, the observed changes in rock samples result mostly from sputtering of sample materials and from reduction of the oxidation state of metal atoms by the action of protons. (auth)

12579 MAGNETIC ACTIVITY AND AURORAS DURING A PROTON FLARE ON THE SUN. Moiseev, B. S. (Arctic and Antarctic Scientific Research Inst., Mirny, Antarctica). Sov. Antarct. Exped. Inform. Bull. (Engl. Transl.); 7: 28-9(Oct 1969).

A proton flare was recorded on the Sun on September 2, 1966. Its coordinates were: $\psi = 21°$ and $\lambda = 65°$. The flare occurred at 5 hr 45 min = UT; it lasted 149 min, and had an intensity of 3B (according to solar data). A strong increase in the level of magnetic activity and enhanced auroral intensity were observed at all Soviet antarctic stations from September 3 to 4 as a result of the flare. Data obtained at Mirny Observatory and at Vostok, Molodezhnaya, and Novolazarevskaya stations were used to analyze magnetic activity and visual auroral observations. A table gives the corrected geomagnetic coordinates of these stations and the most important information on the magnetic storm. The magnetic storm of September 3–4 was the largest recorded in 1966. It was accompanied by a complex of anomalous phenomena in other geophysical processes. For example, radio communications were totally interrupted between Mirny and Vostok on these days and communications between the other stations deteriorated sharply and were poor over the entire period of the storm. The magnetic storm was accompanied by intense auroras of different colors. The logs of visual auroral observations at Mirny, Vostok, Molodezhnaya, and Novolazarevskaya stations were used to analyze and describe these auroras in the period following the proton flare. (BBB)

12580 CHROMOSPHERIC FLARES AND PHENOMENA IN THE UPPER LAYER OF AN ACTIVE REGION. I. Slonim, Yu. M. (Astronomical Inst., Tashkent). Sov. Astron. AJ (Engl. Transl.); 13: 450-8(Nov-Dec 1969).

Translated from Astron. Zh.; 46: 570-9(May-June 1969).

The relationship between flares and rapid processes and stationary filaments in an active region is examined. A physical classification of rapid processes is validated on the basis of the evolution of the magnetic field of a filament. This article shows that surges (DSD, BSD, BSL), ascents, plasma streams from filaments, sudden disappearances of filaments (SDF), and phenomena of eruptive prominences (EPL) are stimulated by the vigorous destruction of the filament field—an explosion of its magnetic envelope. Flares associated with this category of rapid processes have an impulsive nature with a clearly expressed flash phase (type A). These flares are short-lived and are formed in the stage of decay of the magnetic field in a region. Their area correlates well with the width of the Hα line. (auth)

12581 SPECTROSCOPIC INVESTIGATION OF A CHROMOSPHERIC FLARE ON SEPTEMBER 2, 1966. Stepanyan, N. N. (Crimean Astrophysical Observatory, USSR). Sov. Astron. AJ (Engl. Transl.); 13: 459-65(Nov-Dec 1969).

Translated from Astron. Zh.; 46: 580-8(May-June 1969).

Spectra of one node of a chromospheric flare were obtained on September 2, 1966 using a spectrograph with an echelle grating mounted on the Horizontal Solar Telescope of the Crimean Astrophysical Observatory (Sun diameter 30 cm, dispersion from 0.5 to 0.25 Å/mm in the $\lambda\lambda$ 6500 to 3200 Å range). The physical characteristics of the flare at six times during its development were determined from the $H_\gamma - H_{15}$ hydrogen lines (the mechanisms of line broadening, n_e, N_n for n = 5, 6, 10 to 15). The geometric thicknesses of the luminous region were obtained from a comparison of the luminosity of the Ca^+ λ 3736.9 Å line with the theoretically calculated population of the upper levels for that line. These results were compared with the pattern of flare development obtained previously by studying the sequence of emission from metallic lines in flares on the disk and the stratification of the luminosity in the limb flares. It was concluded that two essentially different phenomena are encountered in a flare. The instants corresponding to the initial and repeated maxima on the light curve of the flare correspond to brief luminosity of a small volume of highly excited gas with high velocities of atom motion and an increased electron density. This nucleus acts as the "flare proper." The flat portion of the light curve of the flare corresponds to the luminosity of a gas volume ten times as great with lower velocities and a lower electron density. This can be interpreted as the luminosity of the chromosphere along which the excitation from the "flare proper" is propagated. (auth)

12582 LIMB EFFECT OF THE FRAUNHOFER LINES IN THE SOLAR SPECTRUM. Salman-Zade, R. Kh. (Leningrad

State Univ.). Sov. Astron. AJ (Engl. Transl.); 13: 466-72 (Nov-Dec 1969).

Translated from Astron. Zh.; 46: 589-99(May-June 1969).

Near the limb of the solar disc, the Fraunhofer lines are known to shift toward the red end of the spectrum, compared with their positions at the center of the disc. This "limb effect" has not yet been given a physical basis. Curves of the limb effect obtained by different authors differ greatly, and the proper choice among them is not clear. An attempt was made to obtain a more accurate curve for this effect, particularly to take account of the corrections needed in the various papers on line displacement in general. (auth)

12583 CORRELATION SPECTRAL ANALYSIS OF THE PERIODICITIES IN SOLAR ACTIVITY. Zhukov, L. V.; Muzalevskii, Yu. S. (Central Astronomical Observatory, Pulkovo, USSR). Sov. Astron. AJ (Engl. Transl.); 13: 473-9(Nov-Dec 1969).

Translated from Astron. Zh.; 46: 600-9(May-June 1969).

A statistically adequate method of correlation spectral analysis involving Whittaker's smoothing operator has been applied to Schove's series and the Zürich series of Wolf numbers in order to investigate the periodicities in the variation of the solar-activity index (the Wolf numbers). A monotonically declining component has been found in this variation. Gleissberg's suggestion concerning the presence of a cycle of ≈1000 yr is confirmed. A cycle with a period of ≈200 yr has been detected; the strength of the harmonic for this cycle exceeds that of all the other long-period components. A model in the form of an amplitude–frequency modulation of the harmonic for the 200-yr cycle is proposed for the long-period variations of solar activity. The reality of the claimed 80-yr cycle is open to doubt. It is shown that the identification of such a cycle in the 200-yr Zürich series can be explained by a deviation of the 200-yr solar cycle. Thus methods of long-term prediction based on a cycle of 80 to 90 yr do not reflect essential features of the process and cannot yield correct results. Fine structure has been detected in the 11-yr solar-activity cycle, with individual harmonics having strengths of similar magnitude. (auth)

12584 A STUDY OF THE SOLAR SOFT X-RAY SPECTRUM. Culhane, J. L. (University Coll., London); Stanford, P. W.; Shaw, M. L.; Phillips, K. J. H.; Willmore, A. P.; Bowen, P. J.; Pounds, K. A.; Smith, D. G. Mon. Notic. Roy. Astron. Soc.; 145: 435-55(1969).

A proportional counter x-ray spectrometer, sensitive in the wavelength ranges 1 to 20 Å and 44 to 60 Å, was placed in orbit on the Orbiting Solar Observatory –4. The instrument began to acquire data on October 23, 1967. The spectrometer and its operation are briefly described. Its performance and the method of data analyses are also discussed. Preliminary studies have been made of the slowly varying component of solar x-radiation, the nature of the x-ray active regions in the solar corona and the characteristics of impulsive x-ray events. (auth) (UK)

12585 EQUATIONS OF THE OUTFLOW OF PLASMA FROM THE SUN WITH ALLOWANCE FOR ION COMPOSITION. Konyukov, M. V. (Lebedev Inst. of Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 313-17(1969).

Translated from Geomagn. Aeron.; 9: 385-90(1969).

Equations are obtained of the steady-state spherically symmetric outflow of a multicomponent plasma from the Sun and conditions permitting use of the equivalent hydrogen approximation are established. The uniformity of this approximation is discussed. (auth)

12586 PROPERTIES OF AN INTERPLANETARY PLASMA FLOW AT DIFFERENT MERIDIONAL DISTANCES FROM THE CENTER OF THE ACTIVE REGION. Ivanov, K. G. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 324-6 (1969).

Translated from Geomagn. Aeron.; 9: 398-401(1969).

The distributions of maximum temperatures, proton concentrations, and magnetic field intensity in interplanetary plasma flows along $\Delta\varphi$, i.e., the latitudinal distance from the center of the active region (flow axis), are studied from direct measurements. The highest temperature is observed near the axis of flow ($\Delta\varphi \simeq 0 - 6°$) and then it decreases sharply by a factor of almost 2 and remains practically unchanged to $\Delta\varphi \simeq 20°$. The magnetic field and concentration do not show a marked dependence on $\Delta\varphi$ in the interval between 6 and 20°, but their values are somewhat lower for $\Delta\varphi \simeq 0$ to 6° than for greater latitudinal distances. Concentration and the magnetic field depend significantly on minimum velocity in front of the leading edge of the flow. A schematic model is proposed for the permanent geophysically active flow of interplanetary plasma in its meridional cross section. (auth)

12587 CONDITIONS OF CONSERVATION OF VELOCITY CIRCULATION IN THE SOLAR WIND. Ivanov, K. G. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 428-9 (1969).

Translated from Geomagn. Aeron.; 9: 529(1969).

It is shown that the conditions of conservation of velocity circulation in the solar wind are more rigorous than in hydrodynamics and magnetohydrodynamics and it is very difficult to determine the class of potential currents on the basis of these conditions. The rigidity of the conditions given suggests that current vorticity frequently changes in the solar wind. (W.D.M.)

12588 SOLAR PROTONS IN THE SUBPOLAR STRATOSPHERE DURING THE SOLAR ACTIVITY MINIMUM. Novikov, A. M.; Skryabin, N. G.; Shafer, Yu. G. (Inst. of Cosmophysical Investigations and Aeronomy, Yakutsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 434-6(1969).

Translated from Geomagn. Aeron.; 9: 536-7(1969).

Increases in emission intensity were recorded at atmospheric depths of 100 to 20 g/cm^2 in the stratosphere over Tixie Bay on April 16, July 8, and Oct. 12 and 14, 1965, by single STS-6 gas-discharge counters. The results of the measurements are presented. (W.D.M.)

12589 PROTON FLARES OF JULY 7 AND SEPTEMBER 2, 1966, AND JANUARY 28, 1967. Ageshin, P. N.; Bayarevich, V. V.; Stozhkov, Yu. I.; Charakhch'yan, A. N.; Charakhch'yan, T. N. (Lebedev Inst. of Physics, Moscow. Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 436-8(1969).

Translated from Geomagn. Aeron.; 9: 538-9(1969).

Proton flares were recorded July 7, 1966, Sept. 2, 1966, and Jan. 28, 1967, on balloon sondes in the stratosphere in the Murmansk and Mirny areas. Characteristics of these flares are given. (W.D.M.)

Galaxies

Refer also to abstract 12564.

12590 SIGNIFICANCE OF THE FIRST BRIGHTEST GALAXIES IN RICH CLUSTERS. Peterson, Bruce A. (California Inst. of Tech., Pasadena). Astrophys. J.; 159: 333-40(Jan 1970).

The distributions of absolute magnitudes of the first brightest galaxy in rich clusters of galaxies are computed from a model, and compared with the observed distributions of absolute magnitudes of the first brightest galaxy in clusters of three classes of richness. The model is based on the assumption of a luminosity function for clusters which has a universal form but which allows the masses of clusters to vary. No preference is found for a cluster luminosity function which is or is not cut off at the bright end. A systematic dependence of the average absolute magnitude on richness class is found from the observations, and is predicted by both luminosity functions. (auth)

12591 INTERNAL DUST IN GASEOUS NEBULAE. Mathis, John S. (Univ. of Wisconsin, Madison). Astrophys. J.; 159: 263-75(Jan 1970).

The emergent flux from spherical nebulae is presented as a function of optical depth and albedo of internal isotropically scattering particles. Several different structures of the emission and absorption, including emission-free shells, are considered. In color–color plots, the tracks of increasing optical depth are remarkably insensitive to the geometry of the nebula. For some proposed interstellar particles, such as graphite with and without coatings of ice and hydrogen, the paths in a color–color plot are about the same for both internal and external dust, although the optical depth associated with a given point is about twice as great for internal as for external extinction. The assumption that all dust is external when observed line ratios are corrected for extinction leads to the correct line ratios but may give serious underestimates of the total extinction. In the Orion Nebula, the intensity and color of the scattered light are consistent with about 1.8 mag of internal extinction and 0.35 mag of external extinction. Some planetary nebulae would require impossibly large amounts (several magnitudes) of extinction within the ionized region to explain the Balmer decrement. Nuclei of Seyfert galaxies must be surrounded by shells of dust outside the emission regions, since their colors are more reddened than even infinite optical depth in internal dust can provide. (auth)

12592 COLLISIONS BETWEEN H I CLOUDS. I. ONE-DIMENSIONAL MODEL. Stone, Michael E. (Princeton Univ. Observatory, N. J.). Astrophys. J.; 159: 277-92(Jan 1970).

A numerical, hydrodynamical model was developed for head-on collisions between two identical interstellar clouds. The clouds

were idealized by taking them to be slabs of gas infinite in extent transverse to the direction of collision. Runs were made for several sets of assumptions about the internal thermodynamics, initial homogeneity, presence of gravity, and presence of an internal magnetic field. In all cases strong shocks form at impact and rapidly proceed through the clouds. In the nonadiabatic cases the shocked gas quickly cools and is compressed to very high density. When the shocks reach the outer surface of the coalesced clouds, they disappear, and the gas reexpands. At a point in the reexpansion the surface satisfies the conditions for Rayleigh–Taylor instability so that some gas must be ejected. In general, the time for the expansion to halt and reverse is considerably longer than the mean time between collisions, so that clouds cannot reach even approximate hydrostatic equilibrium between collisions. The gravitational stability of the gas during the compression phase was examined analytically. In the collision direction the gas is very stable, but in the transverse direction perturbations of sufficiently long wavelength grow in time. The most unstable mode has a wavelength of only 3.4 pc, but the growth time is greater than the duration of the compression phase so that the instability cannot manifest itself before the clouds reexpand. (auth)

12593 COLLISIONS BETWEEN H I CLOUDS. II. TWO-DIMENSIONAL MODEL. Stone, Michael E. (Princeton Univ. Observatory, N. J.). Astrophys. J.; 159: 293-307(Jan 1970).

A two-dimensional numerical, hydrodynamical model was developed for head-on collisions between two identical interstellar clouds. The model involves two initially spherical and homogeneous, nonmagnetic clouds of 350 $\mathfrak{M}_\odot$ each, colliding with a relative velocity of 20 km sec^{-1}. The calculations are simplified by assuming that the motion in the direction of collision is independent of transverse position and is equal to the motion on the axis of symmetry. In the direction of collision the motion is nearly identical with that of the one-dimensional model discussed previously. In the transverse direction the very outer layers expand after being shocked. The inner layers contract for a while under the influence of gravity, but the development of a transverse pressure gradient and the reexpansion in the direction of collision prevent gravitational instability. Eventually the entire coalesced mass is left in a state of nearly isotropic expansion with velocity increasing outward. About 25% of the mass reaches escape velocity in the expansion, probably breaking up into low-mass cloudlets during the ejection. Even after 3 times the mean interval between collisions has elapsed, the unejected matter is still not in even approximate hydrostatic equilibrium. This large-scale expansion provides a simple theoretical explanation for the observed velocity dispersion in interstellar lines. (auth)

12594 RADIO EMISSION OF SPIRAL GALAXIES. Tovmasyan, G. M. (Byurakan Astrophysical Observatory, USSR). Astrophysics (Engl. Transl.); 3: 255-8(Winter 1967).

Translated from Astrofizika; 3: 555-64(1967).

Comparison of radio and optical data for the nuclei of 251 galaxies shows that intense radio emission takes place if there is optical evidence for the activity of the nucleus. Moreover, the incidence of radio sources and the intensity of the radio emission depend on the type of nucleus. A correlation is established between the intensity of radio emission and the luminosity of the nucleus. (auth)

12595 DISTRIBUTION OF TRUE FLATTENING OF GALAXIES IN CLUSTERS. Agekyan, T. A.; Sumzina, N. K. (Leningrad State Univ.). Astrophysics (Engl. Transl.); 3: 250-4 (Winter 1967).

Translated from Astrofizika; 3: 545-53(1967).

Assuming that galaxies are oblate ellipsoids of revolution, a relationship is established between the moments of their apparent and true sphericity distributions. Previous data have been used to determine the mean squares of true sphericities and the deviation of the squares of true sphericities of galaxies for 68 galactic clusters. It is shown that differences between the mean squares of sphericities are different for different galactic clusters. A relationship has been found between the moments of the apparent and true sphericity distributions, assuming that the galaxies are prolate ellipsoids of revolution. (auth)

12596 COLORIMETRY OF THE NUCLEI OF NGC 3310 AND NGC 3351. Parsamyan, E. S. (Byurakan Astrophysical Observatory, USSR). Astrophysics (Engl. Transl.); 3: 242-4(Winter 1967).

Translated from Astrofizika; 3: 525-34(1967).

The nuclei of the galaxies NGC 3310 and NGC 3351 were examined colorimetrically. The integrated brightness and the color indices of these regions, and of individual condensations in them, are determined. It is shown that in both galaxies the ultraviolet excess is due largely to condensations whose brightness and dimensions are comparable with those of super associations. (auth)

12597 SCULPTOR-TYPE DWARFS IN GALACTIC CLUSTERS. Karachentseva, V. E. (Byurakan Astrophysical Observatory, USSR). Astrophysics (Engl. Transl.); 3: 245-9 (Winter 1967).

Translated from Astrofizika; 3: 535-43(1967).

The data in the catalog (Karachentseva 1967) were used to analyse the distribution of Sculptor-type dwarfs in near clusters of galaxies. The average parameters of these distributions are reported. There is a correlation between Sculptor-type galaxies and normal elliptic galaxies. (auth)

12598 STUDY OF INTERSTELLAR DUST. Minin, I. N. (Leningrad State Univ.). Astrophysics (Engl. Transl.); 3: 424-8 (Winter 1967).

Translated from Astrofizika; 3: 481-92(1967).

Results are reported of calculations of the brightness, color, and degree of polarization of light from reflection nebulas. The calculations are based on the model of a nebula put forward in an earlier paper (Minin 1964). The results are compared with observations. (auth)

12599 OBSERVATIONS OF NORMAL GALAXIES AT 5 GHz. Whiteoak, J. B. (CSIRO, Sydney). Astrophys. Lett.; 5: 29-32 (Jan 1970).

The results are presented of observations at 5 GHz of the positions and flux densities of 81 radio sources located in directions near normal galaxies. Over 80% have positions within 1 arc min of revised optical centers of the galaxies. Chance association of radio and optical objects may have occurred in seven cases. (auth)

12600 FORMALDEHYDE ABSORPTION IN THE GALAXY. Whiteoak, J. B.; Gardner, F. F. (CSIRO, Sydney). Astrophys. Lett.; 5: 5-10(Jan 1970).

Formaldehyde absorption was detected against 31 out of 34 galactic sources or source components. The clouds with the highest optical depths are found to be physically associated with H II regions. In addition to following the well-known spiral arms, the galactic distribution of the absorbing clouds delineates a spiral feature that is tangential to the line of sight at $l^{II} = 305°$. (auth)

12601 RETENTION OF DUST GRAINS NEAR GALACTIC NUCLEI. Wickramasinghe, N. C. (Kyoto Univ.). Nature (London); 225: 145-7(10 Jan 1970).

It is suggested that grains responsible for the 2.2- to 22-μM infrared radiation from galaxies are charged by the photoelectric effect, and effectively frozen into the ionised gas surrounding the galactic nuclei. (auth) (UK)

12602 FURTHER OBSERVATIONS OF MAGELLANIC CLOUD CEPHEIDS. Gascoigne, S. C. B. (Australian National Univ., Canberra). Mon. Notic. Roy. Astron. Soc.; 146: 1-36(1969).

Two-colour light curves were obtained, mostly by photoelectric photometry, for 13 SMC and 7 LMC cepheids, with periods in the range 1.24 to 6.69 days. The following P–L and P–C relations were found: LMC: $\langle V\rangle = 17.58 - 3.072 \log P$; $\langle B\rangle - \langle V\rangle = 0.49 + 0.191 \log P$; SMC: $\langle V\rangle = 17.73 - 2.879 \log P$; $\langle B\rangle - \langle V\rangle = 0.26 + 0.306 \log P$. The 25 SMC, 18 LMC and 13 galactic cepheids for which the appropriate data are available also obey, to within observational error, the Sandage relation $\langle V\rangle = a - 3.609 \log P + 2.52\,(\langle B\rangle - \langle V\rangle)$ where $a = -2.33$ for the galactic cepheids, 17.03 for the SMC, and 16.40 for the LMC. This implies moduli for 18.73 for the LMC and 19.36 for the SMC. Reddening has been estimated from the colours of field B stars, mostly faint. The author found 0.02 for the SMC and 0.05 for the LMC. With this reddening the SMC cepheids are in the mean about 0.1 mag bluer than those in the Galaxy, as opposed to the 0.2 found previously. Some implications of the above results are briefly discussed. (auth) (UK)

12603 FINE-SCALE STRUCTURE OF VIRGO A. Miley, G. K. (National Radio Astronomy Observatory, Green Bank, W. Va.); Hogg, D. E.; Basart, J. Astrophys. J.; 159: L19-20(Jan 1970).

The nucleus of M87 is shown to coincide with a small radio component of strength 3.9 ± 0.4 flux units. A second component associated with the tip of the optical jet must have an angular size of between 0.5 and 3". (auth)

12604 RADIO SEARCH FOR INTERSTELLAR H_2^+. Jefferts, Keith B. (Bell Telephone Labs., Murray Hill, N. J.); Penzias, Arno A.; Ball, John A.; Dickinson, Dale F.; Lilley, A. E. Astrophys. J.; 159: L15-17(Jan 1970).

A search was made for H_2^+ by using recently determined frequencies. The results were negative, and the upper limits are reported. (auth)

12605 MICROWAVE ABSORPTION OF THE $2_{12} \rightarrow 2_{11}$ ROTATIONAL TRANSITION IN INTERSTELLAR FORMALDEHYDE. Evans II, N. J. (Univ. of California, Berkeley); Cheung, A. C.; Sloanaker, R. M. Astrophys. J.; 159: L9-14(Jan 1970).

The $2_{12} \rightarrow 2_{11}$ rotational transition of H_2CO at 14488.65 MHz was observed in absorption in the direction of Sgr B2, Sgr A, and W51, and upper limits for its intensity set for various other directions. Implications of these observations for radiation at a 2-mm wavelength and for the occurrence of $H_2C^{12}O$ and $H_2C^{13}O$ are discussed. (auth)

12606 MEAN VELOCITY DISPERSION AND THE MASS DISTRIBUTION LAW IN DYNAMICAL SYSTEMS. Nezhinskii, E. M.; Osipkov, L. P. (Leningrad State Univ.). Sov. Astron. AJ (Engl. Transl.); 13: 540-1(Nov-Dec 1969).

Translated from Astron. Zh.; 46: 685-7(May-June 1969).

The mean velocity dispersion in dynamical systems (star and galaxy clusters) as determined from the virial theorem is shown to depend very strongly on the internal mass distribution in the system. It is particularly sensitive to the presence of even a comparatively small relative mass (of order 0.01 to 0.001) at the center of the system. For a given total mass it is shown that the velocity dispersion may be altered by several orders of magnitude if a central condensation is present. (auth)

12607 INTERSTELLAR EXTINCTION AND THE BIMODAL PARTICLE-SIZE DISTRIBUTION. Aivazyan, G. M. (Inst. of Raidophysics and Electronics, Erevan). Sov. Astron. AJ (Engl. Transl.); 13: 488-90(Nov-Dec 1969).

Translated from Astron. Zh.; 46: 620-2(May-June 1969).

In order to explain the extinction curve obtained by Johnson for a region in Cepheus one must use a polymodal distribution of dust-grain diameters, with maxima near 0.15, 3, and 7 μ. This distribution yields the value $2.36 \cdot 10^{-25}$ g/cm^3 for the density of interstellar dust. (auth)

12608 NON-JEANS GRAVITATIONAL INSTABILITY OF A SYSTEM OF STARS AND INTERSTELLAR GAS. Suchkov, A. A. (Astrophysics Inst., Dushanbe, USSR). Sov. Astron. AJ (Engl. Transl.); 13: 418-22(Nov-Dec 1969).

Translated from Astron. Zh.; 46: 534-9(May-June 1969).

The instability of a system of stars and interstellar gas is investigated. It is shown that if the relations $\partial f_0/\partial v|_{v=w-c} < 0$ or $\partial f_0/\partial v|_{v=w+c} > 0$ hold, where $f_0(v)$ is the stellar distribution function, w is the velocity of the interstellar gas, and c is the sound velocity in the gas, the system will be unstable against perturbations of any wavelength. The instability is caused by interaction of a wave with stars whose velocity is close to the phase velocity of the wave. Thus the instability is not of the Jeans type but is kinetic in character, and its mechanism is analogous to the mechanism of inverse Landau damping in plasma. In the solar neighborhood the type of instability considered here could be responsible for the relaxation of the stellar velocity distribution function, but it could not lead to turbulization of the gas and star formation. (auth)

12609 THE SPIRAL STRUCTURE OF GALAXIES. II. Marochnik, L. S.; Suchkov, A. A. (Astrophysics Inst., Dushanbe, USSR). Sov. Astron. AJ (Engl. Transl.); 13: 411-17(Nov-Dec 1969).

Translated from Astron. Zh.; 46: 524-33(May-June 1969).

1. Nonlinear effects. Population I and II stars will tend to diffuse in velocity space through the influence of spiral waves growing because of Landau instability. "Collisions" of the stars with the waves will cause the entropy of the system to increase. A plateau will form in the distribution function for the radial velocities of the Population II stars in the vicinity of the radial phase velocity of the wave, corresponding to the appearance of radial mass flows. Some of the angular momentum of Population I will be transferred to Population II. The velocity dispersion of the stars will increase, and the system will approach a steady state, with spiral waves of finite amplitude generated within it. 2. Solar neighborhood of the Galaxy. The spiral waves are unstable. A spiral pattern of 2 to 4 arms can develop from an arbitrary perturbation in 10^8 to 10^9 yr. It will rotate more slowly than Population I, and a steady state will be established with the finite-amplitude waves that are generated. By this time the peculiar-velocity dispersion of the Population I stars may have doubled as a result of "collisions" with the spiral waves. Populations I and II will form spiral arms that do not coincide in space; they will be displaced relative to each other by ≈200 pc along the radius. The relative density excess in the arms formed by Population I will be approximately four times as great as the corresponding excess in the arms formed by Population II. A radial motion of the local centroid amounting to ~0.5 to 5 km/sec will arise under the action of the spiral waves; this effect may explain the observed vertex deviation. Relaxation of Population I will take place in 10^8 to 10^9 yr through "collisions" between the stars and the waves. For the same reason angular momentum will be transferred from Population I to Population II; this effect is weak in the Galaxy but can be substantial in Sc galaxies. (auth)

12610 PROBLEMS ON EVOLUTION OF RADIO GALAXIES. Melik-Alaverdyan, Yu. K. (Byurakan Astrophysical Lab., Erevan). Dokl. Akad. Nauk Arm. SSR; 47: 134-7(1969). (In Russian).

The available published data were used for establishing a certain relationship between the power of radioemission from a radiosource and the distance from its center to the nucleus of a radio galaxy. Data obtained were in agreement with the simple evolution scheme of radio galaxies suggested by R. A. Vardanyan et al. (Astrofizika, 4: No. 4, (1968)) and with the two assumptions on the adiabaticity of cloud expansion and the steadiness of the rate. (R.V.J.)

12611 COLLAPSE OF INTERSTELLAR GAS CLOUDS. III. NUMERICAL METHODS. Crampin, D. J.; Disney, M. J.; McNally, D.; Wright, A. E. (London Univ.). Mon. Notic. Roy. Astron. Soc.; 145: 423-33(1969).

The finite difference numerical methods used in a solution of the equations of hydrodynamics with gravitation are presented. The accuracy and stability of the methods are discussed and it is shown that iterative procedures remain stable and accurate for an integration time comparable with the free-fall time determined by the initial central density of the cloud. This free-fall time imposes a natural limit to the continuance of the solutions for gas clouds having regions which are almost freely falling. (auth) (UK)

12612 MODEL FOR FORMATION OF A SPHERICAL GALAXY. Larson, Richard B. (Yale Univ., New Haven). Mon. Notic. Roy. Astron. Soc.; 145: 405-22(1969).

Numerical calculations have been made for a model representing the collapse of an initially gaseous proto galaxy and the concurrent transformation of gas into stars. The assumed turbulent motions of the gas are represented by a simple model consisting of discrete colliding clouds, and the star formation rate is assumed to be given as a simple function of the density and turbulent velocity of the gas. The gas clouds and the stars are then treated separately by means of fluid-dynamical equations derived from the Boltzmann equation. It is found that, by assuming reasonable values for the various parameters of the model, it is possible in this way to reproduce reasonably well the observed properties of spherical and nearly spherical galaxies. (auth) (UK)

12613 SPIN TEMPERATURE OF THE INTERSTELLAR NEUTRAL HYDROGEN. Radhakrishnan, V.; Murray, J. D. Proc. Astron. Soc. Aust.; 1: 215-16(Mar 1969).

Observations of the absorption of extragalactic sources by galactic neutral hydrogen indicate that the temperature of neutral hydrogen in the solar neighborhood varies by more than an order of magnitude. (Australia)

12614 AGE OF COSMIC RAYS AND ABUNDANCE OF ANTIMATTER IN THE GALAXY. Libby, L. M. (Univ. of Colorado, Boulder). Nature (London); 225: 166-7(10 Jan 1970).

It is stated that the following four measured cosmic-ray quantities suggest an upper limit to the abundance of antimatter in the Milky Way: (1) the measured abundance of light nuclei; (2) the measured electron/positron ratio; (3) the measured upper limit for the proton/antiproton ratio and for the matter/antimatter ratio of light nuclei; and (4) the constancy of the present cosmic-ray flux for $\gtrsim 10^9$ yr. An upper limit to the abundance of antinuclei of charge ≥3 has been measured as ≲0.19 of the multiple charged nuclei in cosmic rays, and for the antiproton/proton ratio the observed upper limit has been measured as $\lesssim 3 \times 10^{-4}$. The latter value is consistent with the hypothesis that antiprotons are produced by collisions of primary cosmic rays with interstellar matter, while travelling in the galactic disk. The antinuclei/nuclei ratio is consistent with an abundance of interstellar antimatter (Z > 2) of ≲0.1% in the Galaxy and the antiproton/proton ratio with an abundance of antihydrogen of $\lesssim 3 \times 10^{-4}$ for the entire Galaxy. It is concluded that about 50% of cosmic rays are very old (>100×10^6 yrs), and that the average antimatter content of the Milky Way is very small (<0.03%). (UK)

Cosmology

Refer also to abstract 13174.

12615 PROPAGATION OF LIGHT IN UNIVERSES WITH INHOMOGENEOUS MASS DISTRIBUTION. Refsdal, Sjur (Univ. of Nebraska, Lincoln. Univ. of Oslo). Astrophys. J.; 159: 357-75(Jan 1970).

The change in the apparent luminosity and shape of distant light sources due to inhomogeneities in the Universe that cause gravitational deflections of the light rays is discussed. The case explored in most detail is a static and flat universe with randomly distributed mass points and with pointlike light sources. Ray-tracing technique by means of a computer is used. It is shown that the results found in the case of static and flat universes in most cases can be applied to expanding and curved universes with fairly good approximation. The validity of the point-source and point-deflector approximation is briefly examined, and the changes one has to expect if the approximation is not valid are indicated. (auth)

12616 NATURE OF THE BETA CEPHEI PHENOMENON. Percy, John R. (Univ. of Toronto). Astrophys. J.; 159: 177-82(Jan 1970).

Observational data indicate that the β Cephei instability strip lies about 1.85 mag above the main sequence at its upper end and 1.35 mag above the main sequence at its lower end. It terminates abruptly at or near $M_v = -3.0$. The true instability strip may be less inclined to the main sequence. Evidence suggests that the instability strip lies coincident with the terminal phases of hydrogen burning in the star's evolution. It is hypothesized that the β Cephei phenomenon arises as a result of a semiconvective zone within the star. At a certain critical central hydrogen content, the semiconvective zone becomes extensive enough so that its postulated destabilizing effects overcome the decreasing stabilizing effects of the envelope. Stars fainter than $M_v = -3.0$ do not become β Cephei stars, because they do not have semiconvective zones. (auth)

12617 NEW LIMITS ON THE SHEAR AND ROTATION OF THE UNIVERSE FROM THE X-RAY BACKGROUND. Wolfe, A. M. (Univ. of California, San Diego). Astrophys. J.; 159: L61-7(Jan 1970).

It is shown that recently set upper limits of 1% on 12- and 24-hour angular variations in the x-ray background radiation lead to restrictions on large-scale shear and vorticity for approximately half of the sky. Because of a global analogy to the Compton–Getting effect, the limiting values placed on the shear and vorticity are of the same order as those set by the isotropy of the microwave background (over a small solid angle) if intergalactic hydrogen now exists at densities $>10^{-6}$ cm^{-3} for the shear model, and $>10^{-7}$ cm^{-3} for the vorticity model. If intergalactic hydrogen does not exist, the limits are not as significant as those implied by the microwave background, but are still important because of the large solid angle scanned in the observations. A "Euclidean," axisymmetric world model with shear, and two models containing vorticity and having open and closed geometries, are used in the calculations. (auth)

12618 GEODESICS OF ROBERTSON–WALKER UNIVERSES. Noerdlinger, Peter D. (Inst. of Mining and Tech., Socorro, N. Mex.). Phys. Rev.; 186: 1347-51(25 Oct 1969).

The complete set of geodesics is obtained for Robertson–Walker universes with arbitrary R(t), from those geodesics whose spatial projections pass through the origin, by inducing a translation of origin through the rotation of a hypersphere whose stereographic projections form the space sections. The results are applied to the calculation, in a Milne universe, of the angular displacement of a particle initially projected at high velocity across the line of sight. This displacement proves to be bounded, the upper bound being attained reasonably fast, on a cosmic time scale. (auth)

12619 INTERACTION OF COSMIC-RAY PARTICLES WITH RADIATION IN AN EXPANDING UNIVERSE. Prilutskii, O.; Rozental', I. L. (Inst. of Physical Engineering, Moscow). Sov. Astron. AJ (Engl. Transl.); 13: 381-4(Nov-Dec 1969). Translated from Astron. Zh.; 46: 481-5(May-June 1969).

All the processes for the interaction of cosmic-ray protons and high-energy heavy nuclei with radiation in the Universe are considered. Special attention is given to estimating the influence of light on the cosmic-ray energy spectrum. The possible evolution of extragalactic light sources is taken into account. A comparison is made with experimental data on the cosmic-ray spectrum at very high energies. (auth)

12620 RADIATION CATASTROPHE. Harrison, E. R. (Univ. of Massachusetts, Amherst). Nature (London); 225: 245(17 Jan 1970).

According to the "big bang" theory, the Universe consisted initially of almost equal quantities of matter and antimatter, and from the present densities of matter and radiation, it is possible to estimate the differences in the quantities of matter and antimatter in the early Universe. The possibility of a radiation catastrophe was discussed in a recent review of antimatter and cosmology (Steigman, Nature, 224: 477(1969)); it was argued that if the Universe were charge-symmetric it would contain radiation many orders of magnitude denser than at present observed. The author of this note argues that such a radiation catastrophe did not occur, and that the real catastrophe in a charge-symmetric Universe is not an abundance of radiation, but the absence of either matter or antimatter. (UK)

12621 GRAVITATIONAL RADIATION EXPERIMENTS. Weber, J. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev. Lett.; 24: 276-9(9 Feb 1970).

A summary is given of the statistics and coincidences of the Argonne-Maryland gravitational-radiation-detector array. New experiments were carried out. These include a parallel coincidence experiment in which one coincidence detector had a time delay in one channel and a second coincidence detector operated with no time delays. Other experiments involve observations to rule out the possibility that the detectors are being excited electromagnetically. These results are evidence supporting an earlier claim that gravitational radiation is being observed. (auth)

12622 NON-STATIC FLUID SPHERES IN GENERAL RELATIVITY. Faulkes, M. C. (Queen's Univ., Kingston, Ont.). Progr. Theor. Phys. (Kyoto); 42: 1139-42(Nov 1969).

An exact solution for a spherically symmetric distribution of inhomogeneous matter in an empty background is derived and investigated. The solution serves as a simple model for gravitational collapse. (auth)

Planetary Phenomena

12623 COMMENCEMENT TIMES AND DURATIONS OF JUPITER'S RADIO-NOISE STORMS. Olsson, C. N. (Univ. of Florida, Gainesville); Smith, A. G.; Register, H. I.; May, J. Icarus; 11: 212-17(Sep 1969).

Analysis of 10 years of observations confirms Duncan's conclusion that the commencement times of Jupiter's decametric noise storms define a constant planetary rotation period, the value for which in the present investigation is 9h 55m 29.37s. However, the study indicates that the apparent 12-year oscillation in the longitudes of the centers of the conventional sources does not result from a simple variation in storm length. (auth)

12624 JUPITER, THE ROSETTA STONE OF THE SOLAR SYSTEM. Rasool, Ichtiaque (Goddard Inst. for Space Studies, New York). Naturwiss. Rundsch.; 22: 379-83(Sep 1969). (In German).

Radio emission from Jupiter at 20 MHz appears as sporadic storms of minutes to several hours' duration; the energy can reach 10^{21} erg. It can be modulated by the position of Io, for when Io is about 90° from superior conjunction, the radiation is five times stronger. The radiation in the region of 3 to 100 cm wavelength is also exceptional. An explanation for this activity can be incorporated into present theory by the assumption of a magnetic field for Jupiter of 10 to 50 gauss at the surface. Io falls within the magnetosphere, and its influence must be explained by the interaction of a rapidly moving plasma with a body of unknown conductivity. Interpretations of the red spot and other spectral features of the planet are discussed. Correlations of particle density in the Earth's Van Allen belt would be of help in furthering understanding. (BBB)

Atomic and Molecular Physics

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 12789 and 13235.

12625 (AD-691762) ENERGY LOSS OF HIGH-ENERGY ELECTRONS IN ALUMINUM AND COPPER. Goodwin, James C. Jr. (Naval Postgraduate School, Monterey, Calif.). Dec 1968. 73p. CFSTI.

The LINAC at NPGS, Monterey was used to accelerate electrons to energies ranging from 50 to 100 MeV. These were used to study energy losses of high-energy electrons in aluminum and copper. The densities of each material ranged from 0.7 to 2.8 g/cm^3. The

results agreed with the theory of Blunck and Westphal, unlike previous measurements made by Breuer who found disagreement between his experimental results and his interpretation of the theory of Blunck and Westphal, particularly at energies above 50 MeV and with aluminum of thickness greater than 1 g/cm^2. (auth) (USGRDR)

12626 (CEA-R-3942) ENERGY LOSSES, RANGE, AND BREMSSTRAHLUNG YIELD FOR 10-keV TO 100-MeV ELECTRONS IN SOME SIMPLE ELEMENTS AND SOME CHEMICAL COMPOUNDS. Pages, Lucien; Bertel, Evelyne; Joffre, Henri; Sklavenitis, Laodamas (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jan 1970. 142p. (In French). Dep. CFSTI (U. S. Sales Only).

The study of tissue-equivalent materials for dosimeters necessitates calculation of some physical characteristics (particularly the electron stopping power) of mixtures studied. In order to determine the stopping power, the energy losses by ionization and bremsstrahlung were calculated separately. The energy losses by ionization were calculated from the Bethe "slowing down" theory. Moreover, in order to take the density effect into consideration, the basic functions established by Fermi were used instead of usual empirical relations. The energy losses by emission of bremsstrahlung were calculated according to the formulas proposed by Koch and Motz. A program was developed and written in Fortran IV for an IBM 360-91 computer. The stopping powers, the range, and the bremsstrahlung yields of electrons with energy between 10 keV and 100 MeV were calculated according to this program particularly for all the elements used in the development of tissue-equivalent mixturès. (France)

12627 INFLUENCE OF MULTIPLE SCATTERING ON 250- TO 600-MeV ELECTRONS IN LAMINATED MEDIA. Arutyunyan, F. R. (Inst. of Research in Physics, Erevan). Dokl. Akad. Nauk Arm. SSR, 48: No. 1, 32-5(1969). (In Russian).

The influence of multiple scattering on electron emission for 250- to 600-MeV energies in a stratified layer was studied in the spectral range $\hbar\omega$ = 10 to 100 keV. Experimental data were compared with the theory of resonance radiation which did not consider the influence of multiple scattering of electrons in stratified media. It was shown that in a thin stratified media, the experimental spectra were in good agreement with theory. However, in thick-layer laminar media, the electron yield was much higher than expected according to the resonance emission theory. Differential spectra for resonance electron emission at various energy in a laminar media consisting of 1050 layers of paper of 2.83×10^{-3} cm thickness distributed in air at 5.32×10^{-2} cm distance from each other and the differential spectra of electron radiation in 300 layers of paper of 2.43×10^{-2} cm thickness each and distributed in the air at 2.15×10^{-1} cm from each other are correlated and analyzed. (R.V.J.)

12628 SECONDARY EMISSION OF Mo^+ IONS DURING BOMBARDMENT OF MOLYBDENUM BY ALKALI-METAL IONS. Adylov, A. A.; Veksler, V. I.; Reznik, A. M. (Tashkent State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 11: 1441-7(Jan 1970).

Translated from fiz. Tverd. Tela; 11: 1779-87(Jul 1969).

Secondary emission of Mo^+ ions during bombardment of pure and impure molybdenum by Cs^+ and K^+ ions has been studied. Experimental energy spectra were found for Mo^+ ions for various primary-ion energies (300 to 2800 eV). Spectra for the contaminated surface, calculated from the pure-surface spectra taking into account elastic scattering of Mo^+ ions by contaminant atoms, agree with the experimental data. The temperature dependences of the Mo^+ yield for pure and contaminated surfaces have been found. The time dependence of the secondary Mo^+ current for various target temperatures, bombarding-ion current densities, and pressures is explained by the formation of chemical compounds on the surface, activated by the ion bombardment, and by the ejection of Mo^+ ions from contaminated parts of the surface free of atoms adsorbed from the primary beam. (auth)

12629 ON THE SPUTTERING MECHANISM IN THE ENERGY RANGE OF RUTHERFORD BACKSCATTERING. Behrisch, R.; Weissmann, R. (Institut fuer Plasmaphysik, Garching, Ger.). Phys. Lett.; 30A: 506-7(29 Dec 1969).

Sputtering rates for 100-keV protons incident normally on Cu and Pt films deposited on various base materials were determined from the energy spectrum of the backscattered protons. Sputtering is partly caused by ions backscattered from the base material. (auth)

12630 ENERGY DISTRIBUTION OF ELECTRONS AFTER MULTIPLE SCATTERING IN THIN METALLIC FILMS. Gusev, E. A.; Kanonov, B. A. (Physical-Technical Inst., Tomsk, USSR. Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 8, 137-9(1969). (In Russian).

Studies were made of the spectral distribution of 2.91- and 5.89-MeV electrons behind the Be, Mg, Cu, Sn, and Bi barriers ($t_{max} \leq 6$ mg/cm^2) at angles of 0 to 2° to the incident beam axis at 0.67° intervals. The results showed that the spectral shape of the scattered beam was identical to the spectral distribution of the incident beam and is not a function of the thickness of the film and of Z. Curves were constructed of electron energy distribution behind Be t = 3.39 mg/cm^2 (E_{init} = 2.91 MeV) and Bi t = 3.2 mg/cm^2 (E_{init} = 5.89 MeV) as functions of the angle of electron emergence. The data may be used for determining the passage of relativistic electrons through monocrystalline films. Any deviations from the observed regularities in the energy and angular distribution were related to the influence of crystal structure. (R.V.J.)

12631 INELASTIC SCATTERING OF FAST ELECTRONS BY CRYSTALS. Ishida, Kohtaro (Tokyo Univ.). J. Phys. Soc. Jap.; 28: 450-7(Feb 1970).

Effects of inelastic scattering on the diffraction of fast electrons by a crystal are studied. The Bragg reflections of both elastically and inelastically scattered electrons are considered. The absorption coefficients of wave fields and their dependences on the diffraction condition are derived. The results of the theory are applied to the intensity distributions of "equal thickness fringes" in electron microscopic images formed by elastically and inelastically scattered electrons. The effects of the interband and intraband transitions on the images formed by inelastically scattered electrons are studied. The applications of this theory to thick-crystal and multiple scattering are discussed. (auth)

12632 FAST H(2S) ATOMS FROM ELECTRON BEAM EXCITATION OF POLYETHYLENE. Clampitt, R. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Polymer; 10: 721-2(Aug 1969).

The detection and time-of-flight resolution of H(2S) atoms ejected from polyethylene by low-energy electron impact (<50 eV) are reported. A pulsed electron beam (~10 μA) of 200 nsec duration and 5 kHz repetition rate was employed, impinging on a piece of polyethylene covered with wire mesh to minimize electrical charging. The mean kinetic energy of the ejected H(2S) atoms was 1.5 ± 0.2 eV, a value very close to that for H(2S) atoms from gaseous ethylene (1.6 ± 0.2 eV), and the threshold electron energy for H(2S) production from polyethylene, obtained by a delayed coincidence method, was estimated as ~15 eV. It is suggested that the fast electronically excited and long-lived atoms produced by low-energy electrons may subsequently cause dissociation of neighboring C–H bonds with considerably higher efficiency than an electron of the same energy. (UK)

12633 ALPHA-PARTICLE STOPPING CROSS SECTION IN SOLIDS FROM 400 keV TO 2 MeV. Chu, W. K.; Powers, D. (Baylor Univ., Waco, Tex.). Phys. Rev.; 187: 478-90(10 Nov 1969).

Stopping cross sections of α particles from 400 keV to 2 MeV have been measured to an accuracy of ±3.6 to ±4.9% in 17 elements (Be, C, Mg, Al, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Ge, Pd, Ag, In, and Sn). The experimental method consists of the elastic scattering of α particles from a thick Ta backing onto which a thin layer of target element has been evaporated. The energy loss of α particles in the target film is determined by the difference in energy between α particles scattered from clean Ta and α particles scattered from Ta after having gone through the thin layer of target element. The results are compared with measurements by Porat and Ramavataram and by Gobeli and with estimates by Whaling; the discrepancies range from 1 to 20%. Structure in and a decrease of the α-particle stopping cross section ϵ_α with stopping element atomic number Z_2 are noticed in the region Z_2 = 22–29. This dependence is not predicted by the Bethe–Bloch formalism valid at higher velocities, nor by the Firsov or the Lindhard formalism valid at lower velocities. The oscillatory structure of ϵ_α on Z_2 is discussed qualitatively by comparing $\epsilon_\alpha(E_\alpha)$ versus Z_2 with a Hartree–Fock–Slater potential $\phi(r)$ versus Z, with E_α related to the radius r by a velocity comparison. An empirical formula for $\epsilon_\alpha = \epsilon_\alpha(E_\alpha, Z_2)$ has been constructed from the present measurements. (auth)

12634 ELECTRONIC STOPPING CROSS SECTIONS FOR ^{1}H AND ^{4}He PARTICLES IN Cr, Mn, Co, Ni, AND Cu AT ENERGIES NEAR 100 keV. White, W.; Mueller, R. M. (Nuclear-Chicago Corp., Des Plaines, Ill.). Phys. Rev.; 187: 499-503(10 Nov 1969).

Electronic stopping cross sections have been measured for 30- to 140-keV ^{1}H and 50- to 120-keV ^{4}He particles in Cr, Mn, Fe, Co, Ni, and Cu ($24 \leq Z_2 \leq 29$). In this Z_2 region, the cross sections at a given energy show a steady decrease with increasing Z_2, thus confirming and extending earlier observations. The combined data show a dependence on Z_2 markedly similar to the periodic depen-

dence of electronic stopping cross sections on the Z of the projectile. The measurements were made utilizing high-resolution solid-state-detector spectra of the particles backscattered from thin films of the target materials evaporated on thick substrates. The probable error of the stopping-cross-section measurements is 3%. (auth)

Atomic and Molecular Properties

Refer also to abstracts 12826 and 13428.

12635 DETERMINATION OF ELECTRON TEMPERATURE FROM THE ABSOLUTE INTENSITY OF THE 4686 A He II LINE IN A SOURCE OF MULTIPLY CHARGED IONS. Romanov, N. P. Opt. Spectrosc. (USSR) (Engl. Transl.); 26: 376-9(May 1969). Translated from Opt. Spektrosk.; 26: 683-8(May 1969).

It is shown that in the helium plasma with $n_e = 1.2 \times 10^{14}$ cm^{-3} the n = 4 level of the helium ions, which is the initial state of the 4686 Å He II line, is caused mainly by its excitation from the ground state by electron impact. About 20% of all electrons arrive at the n = 4 level from other levels. When that level is depopulated about 40% of all electrons go to levels with n > 4, and the rest disappear because of spontaneous emission. The electron temperature $T_e = 9.5$ eV was determined from the measured population of the level in question, taking these processes into consideration. (auth)

12636 QUADRUPOLE MOMENT OF ^{59}Co. Murakawa, Kiyoshi (Tokyo Denki Coll.). J. Phys. Soc. Jap.; 27: 1690(Dec 1969).

The hfs of the λ4234 line ($3d^74s^2\ ^4F_{9/2} - 3d^74s4p^6F_{7/2}$) of Co I was measured. The hfs of the upper level was calculated to be A = 28.705×10^{-3} cm^{-1} and B = 3.37×10^{-3} cm^{-1}. The quadrupole moment Q is calculated to be 0.49 b without shielding correction. If the Sternheimer correction for 4p is assumed to be the same for Cu I and Co I, Q = 0.49/1.175 = 0.42 b. (D.L.C.)

12637 POLARIZATION OF THE RADIATION INDUCED BY ELECTRON IMPACT ON He AND Hg. Heideman, H. G. M.; Smit, C.; Smit, J. A. (Univ., Utrecht). Physica; 45: 305-20 (24 Nov 1970).

The polarization of a number of He and Hg spectral lines, excited by a beam of electrons, has been measured as a function of the electron energy. The transitions studied are: for helium $4^1D \rightarrow 2^1P$, $5^1D \rightarrow 2^1P$, $4^3S \rightarrow 2^3P$, $3^3D \rightarrow 2^3P$, $4^3D \rightarrow 2^3P$; for mercury $6^1D_2 \rightarrow 6^1P_1$, $6^3D_2 \rightarrow 6^1P_1$, $7^3S_1 \rightarrow 6^3P_1$, and $7^1D_1 \rightarrow 6^1P_1$. The electron energy was varied from the threshold energy to a few eV above it. The results indicate that in most cases the polarization measured near the threshold is much lower than the theoretically predicted threshold polarization. For some transitions a detailed structure near threshold is observed in the polarization function. The observed behavior of the polarization near threshold is discussed and a qualitative interpretation is presented. (auth)

12638 NEW DIAGRAM LINES IN THE L-EMISSION SPECTRUM OF TERBIUM. Nigam, A. N.; Garg, K. B. (Univ. of Rajasthan, Jaipur, India). Physica; 45: 203-4(24 Nov 1969).

Using curved-crystal transmission spectrographs of radii 40 cm and 20 cm, the L-emission spectrum of terbium was investigated in the beta–gamma region. Two new diagram lines at 1552.7 and 1559.1 x.u., corresponding respectively to the quadrupole transition $L_{II}\ N_{III}$ and the forbidden transition $L_{II}\ N_{II}$, are reported for the first time. (auth)

12639 QUADRUPOLE TRANSITION $L_{II}\ N_{III}$ IN Er. Nigam, A. N.; Kapoor, Q. S. (Univ. of Rajasthan, Jaipur, India). Chem. Phys. Lett.; 4: 455-6(15 Dec. 1969).

Using a 20-cm curved mica crystal spectrograph of the transmission type, a new diagram line was observed at λ = 1382.9 x.u. in the L spectrum of erbium. This has been assigned to the quadrupole transition $L_{II}N_{III}$. (auth)

12640 HYPERFINE STRUCTURE IN THE MOLECULAR ION H_2^+. Jefferts, K. B. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Lett.; 23: 1476-8(29 Dec 1969).

Thirty transitions between hyperfine levels of H_2^+ were observed. This is the first observation of the complete hyperfine structure for this system. The measured transition frequencies range from 3.989 to 1276.271 MHz, and fully define the hyperfine energy level schemes for the rotational states K = 1 and K = 2 and the vibrational states v = 4 to 8. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstracts 12647, 12896, and 12995.

12641 QUALITATIVE PROPERTIES OF MUONIC HYDROGEN METALS. McKenna, P.; Pastine, D. John (Naval Ordnance Lab., White Oak, Md.). Phys. Rev. Lett., 23: 1508-10(29 Dec. 1969).

The cohesive energy and density of metals that theoretically should condense in high-pressure systems containing high concentrations of muons and various isotopes of hydrogen are calculated qualitatively. The resulting metallic forms are found to be thermally superstable suggesting that they may perhaps exist briefly and in small quantities in some stellar environments. (auth)

Collision Phenomena

Refer also to abstracts 11871 and 11885.

12642 HARD-SPHERE CORRECTION FOR ION–MOLECULE COLLISIONS. Peers, A. Mackenzie (Laboratoire Curie, Paris). J. Mass Spectrom. Ion Phys.; 3: 99-102(Sept 1969).

The critical ion kinetic energy at which "hard-sphere" dimensions begin to influence the charge-induced dipole collision cross section is shown to be lower than previous estimates by a factor of four. Some typical critical energies are tabulated and equations for the collision cross section at greater than critical energies are given. (auth)

12643 RAMSAUER EFFECT AS A RESULT OF THE DYNAMIC STRUCTURE OF THE ATOMIC SHELL. Gryzinski, Michal (Inst. of Nuclear Research, Swierk, Poland). Phys. Rev. Lett.; 24: 45-7(12 Jan 1970).

A method of treating elastic atomic collisions on the basis of classical physics is suggested. The treatment is based on the multipole representation of atomic fields. Results for low-energy electron scattering on argon are shown. (A.G.W.)

12644 ENERGY SPECTRA OF ELECTRONS FROM AUTOIONIZATION STATES IN HELIUM BY ELECTRON IMPACT. Oda, N.; Nishimura, F.; Tahira, S. (Tokyo Inst. of Tech.). Phys. Rev. Lett.; 24: 42-5(12 Jan 1970).

Energy spectra of electrons ejected from autoionization states in helium excited by electron impact were measured at bombarding energies from 65 to 250 eV as a function of the angle to the primary electron beam. The height of peaks of the energy spectra due to optically forbidden transitions from the ground state compared with those due to optically allowed transitions increases as the impact energy is reduced; this trend was most marked for the triplet-state $(2s2p)^3P$ excitation. (auth)

12645 QUENCHING OF METASTABLE HYDROGEN. Byron, F. W., Jr.; Krotkov, R. V.; Medeiros, John A. (Univ. of Massachusetts, Amherst). Phys. Rev. Lett.; 24: 83-6 (19 Jan 1970).

Measurements are reported on the quenching of metastable hydrogen atoms by helium, neon, argon, H_2, and N_2, all in the energy range 0.5 to 4.5 keV. For helium, the measured cross sections are in good agreement with the results of a calculation using the eikonal method. This theoretical treatment leads to the conclusion that polarization of the helium atom is important and that the quenching is not dominated by a single process, such as 2s–2p transitions. (auth)

12646 OSCILLATIONS IN $Cs^+ + Cs$ AND $K^+ + K$ CHARGE-TRANSFER CROSS SECTIONS. Dewangan, D. P.; Karmohapatro, S. B. (Saha Inst. of Nuclear Physics, Calcutta). Phys. Rev. Lett.; 24: 1-3(5 Jan 1970).

Charge-transfer cross sections of $Cs^+ + Cs$ and $K^+ + K$ are calculated by the impact-parameter method using suitable atomic wave functions. The theoretical cross sections as a function of ion velocity show oscillatory structure in qualitative agreement with the experimental values given by Perel and co-workers. (auth)

12647 POSITRONIUM FORMATION IN POSITRON–HELIUM SCATTERING: A CALCULATION. Fels, Margaret Fulton. Davis, Calif.; Univ. of California (1968). 121p. Thesis.

An approximation method developed by Chen and Mittleman has been used to investigate the process of positronium formation in positron–helium scattering. The energy range in which only ground-state positronium may be formed is considered. This method leads to an approximation made on a projection-operator technique, and further includes a coordinate change that allows the expression of the entire problem in terms of the positron coordinate. The result is two coupled ordinary differential equations of second order, which may be solved numerically. The projection-operator technique leads naturally to the inclusion of the polarizability of both helium and positronium in the potentials that appear in the final equations, and a thorough investigation is

made of the effects of various forms for the polarization potentials. From the several approximations used in this calculation, the cross sections obtained for positronium formation are small, with the largest value approximately equal to $0.002\ \pi a_0^2$. This is to be compared with the corresponding value of $0.3\ \pi a_0^2$ for the elastic cross section. The results await a comparison with experimental data expected to be made available in the near future. (Diss. Abstr. Int., B)

12648 ENERGY SPECTRA OF ELECTRONS RELEASED IN COLLISIONS BETWEEN FAST ALKALI METAL ATOMS AND He AND Ne ATOMS. Ogurtsov, V. I.; Bydin, Yu. F. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz.; 57: 1908-16(Dec 1969). (In Russian).

The energy spectra of electrons ejected in collisions between fast Na, K, Rb, and Cs atoms with He and Ne atoms are studied. The energies of the Na atoms varied between 200 and 3000 eV, those of the Rb atoms between 500 and 3000 eV, of the K atoms between 260 and 3000 eV, and of the Cs atoms between 1500 and 2950 eV. The measurements were performed by the retarding-potential technique, and electrons moving perpendicular to the primary beam of neutral atoms were recorded. It is shown that along with the group of "slow" electrons whose behavior in general can be predicted by the Demkov–Komarov theory, faster electrons are also produced. For certain combinations of the partners intense discrete electron groups were observed. Their appearance is interpreted as being the result of excitation of autoionized states of the alkali metal atom. (auth)

12649 SOME PROPERTIES OF THE He^+ AND He^{2+} ION FORMATION CROSS SECTIONS IN He^{2+}–He COLLISIONS. Latypov, Z. Z.; Flaks, I. P.; Shaporenko, A. A. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz.; 57: 1987-90(Dec 1969). (In Russian).

The cross sections σ_{01} and σ_{02} for formation of slow He^+ and He^{2+} ions in collisions between He^{2+} ions and He atoms are determined experimentally for energies $0.4 \le T \le 8$ keV. In the low-energy region the function $\sigma_{01}(T)$ has a pronounced structure apparently due to the one-electron charge-exchange process $He^{2+} + He \rightarrow He^+ + He^+$. It is suggested that the structure of the one-electron charge-exchange curve is due to intersection between terms of the $He^{2+} + He(1s^2)$ systems with some terms of the $He^+(nl) + He^+(1s)$ and $He^{2+} + He(1s,nl)$ systems. (auth)

12650 SLOW COLLISIONS IN A SYSTEM OF THREE BODIES INTERACTING ACCORDING TO THE COULOMB LAW. Matveenko, A. V.; Ponomarev, L. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz.; 57: 2084-94(Dec 1969). (In Russian).

The scattering phase shifts and cross sections for the process of symmetric charge exchange $p + H(1s) \rightarrow H(1s) + p$ are determined by the perturbed stationary states method for collision energies between 10^{-5} and 5 eV. The phase shifts are calculated on the basis of the equations of the phase function method, which yields values with a prescribed accuracy. For a concrete physical problem the results obtained permit one to derive some general regularities in the behavior of the partial phase shifts and cross sections, to elucidate the limits of applicability of the Born approximation for calculation of these quantities, and also to illustrate the peculiarities of transition from low collision energies to high energies. In the antisymmetric $2p\sigma$ state of the molecular hydrogen ion H_2^+ a weakly bound state with a binding energy $J \approx 4 \times 10^{-4}$ eV is found to exist for a large equilibrium distance between the nuclei $R_0 \approx 12.55$ a.u. (auth)

12651 ROTATIONAL EXCITATION OF H_2 BY SLOW ELECTRONS. Hara, Shunsuke (Tokyo Univ.). J. Phys. Soc. Jap.: 27: 1592-7(Dec 1969).

The differential and integrated cross sections for the rotational excitation ($0 \rightarrow 2$ and $1 \rightarrow 3$) of the hydrogen molecule by slow electrons are calculated in the adiabatic approximation. The effects of electron exchange and target polarization on the rotational excitation are investigated. Inclusion of these effects increases cross sections and results in good agreement with experimental data. (auth)

12652 EVALUATION OF INTEGRALS REQUIRED IN SCATTERING THEORY: I. NON-EXCHANGE TYPE INTEGRALS. Lyons, J. D.; Nesbet, R. K. (IBM Research Lab., San Jose, Calif.). J. Comput. Phys.; 4: 499-520(Dec 1969).

In any many-body variational approach to electron–atom scattering theory certain types of matrix elements not encountered in bound-state problems must be evaluated. In this paper the new integrals that occur are identified and procedures for obtaining all but the exchange-type integrals in all reasonable cases are presented. The techniques discussed are oriented toward rapid and accurate evaluation on a computer. A number of previously unpublished formulas and properties of integrals involving spherical Bessel functions are presented. (auth)

12653 INTEGRALS FOR ELECTRON-ATOM SCATTERING CALCULATIONS. Harris, Frank E. (Univ. of Utah, Salt Lake City); Michels, H. H. J. Comput. Phys.; 4: 579-93(Dec 1969).

The integrals needed for expansion calculations of electron–atom scattering are identified and classified. Methods are described for evaluating all integrals, using Slater-type orbitals for the bound-state functions and free-wave functions built from spherical Bessel functions and spherical harmonics. (auth)

12654 PHASE-INTERFERENCE EFFECTS IN INELASTIC $He^+ + He$ COLLISIONS. Rosenthal, H.; Foley, H. M. (Columbia Univ., New York). Phys. Rev. Lett.; 23: 1480-3(29 Dec 1969).

In the collision $He^+ + He \rightarrow He^+ + He^*$, excitation at low incident ion energies ($\lesssim 1$ keV) proceeds via a pseudocrossing of the elastic $^2\Sigma_g$ diabatic potential with excited-state $^2\Sigma_g$ potentials. In addition, pseudocrossings of inelastic potentials at large internuclear separations mix the amplitudes of the excited-state channels coherently. This many-state mechanism provides qualitative understanding of diverse experimental observations. (auth)

12655 EXPERIMENTAL TESTS OF THE POST-COLLISION-INTERACTION MODEL FOR THE He^+–He EXCITATION FUNCTIONS. Dworetsky, S. H.; Novick, R. (Columbia Univ., New York). Phys. Rev. Lett.; 23: 1484-8(29 Dec 1969).

New data on the excitation of helium by low-energy helium ions were obtained that provide strong support for the post-collision-interaction model proposed by Rosenthal and Foley in a companion paper. Certain details of the results not presently predicted by the theory are pointed out. (auth)

Atomic Theory

12656 RELATIVISTIC THEORY OF A HEAVY ATOM. Braun, M. A.; Dmitriev, Yu. Yu.; Labzovskii, L. N. (Leningrad State Univ.). Zh. Eksp. Teor. Fiz.; 57: 2189-97(Dec 1969). (In Russian).

A method for calculation of relativistic corrections is formulated, which is equally valid for outer and inner electrons in the atom. The initial approximation is a relativistic version of the self-consistent-field method. All diagrams containing a single virtual photon line are considered. After removal of all divergences for the energy-level shift a finite expression is obtained, which contains an integral over configurational space and sums over intermediate electron states. A variational principle is proposed for evaluation of the sums. (auth)

Cosmic Radiation

Refer also to abstracts 11844, 12540, 12614, 12619, 12941, and 13017.

12657 (AECL–3473) COSMIC RAY MT-64 MUON MONITOR DATA. IV. FROM SOLAR ROTATION 1840 TO ROTATION 1852 (JANUARY 19, 1968 TO JANUARY 3, 1969). Steljes, J. F. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Nov 1969. 89p. Dep. CFSTI (U. S. Sales Only). AECL $2.00.

Hourly rates corrected for atmospheric temperature and pressure from four cosmic-ray stations in Canada which have muon monitors maintained by AECL and from a survey monitor stationed at Kula, Hawaii, are given in tabular form by solar rotation for the period from the beginning of Rotation 1840 to the end of Rotation 1852 (January 19, 1968 to January 3, 1969). The Dorman–Maeda temperature correction factors for each station calculated at 12 hour intervals from the radiosonde data of the Canadian Meteorological Branch or the U. S. Weather Bureau are also listed. Barometric pressures are available from neutron monitor data reports already published. Graphs of the relative hourly rates at each station are given. (auth)

12658 (AECL–3479) COSMIC RAY NEUTRON AND MUON MONITOR DIURNAL VECTORS. I. FROM THE START-UP OF THE STATIONS TO THE END OF SOLAR ROTATION NO. 1812 (JANUARY 19, 1966) AND VECTOR DIAGRAMS BY SOLAR ROTATION. Steljes, John F. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Oct 1969. 79p. Dep. CFSTI (U. S. Sales Only). AECL $2.00.

Daily diurnal and semi-diurnal variation vectors for both the muon and the neutron monitors at 4 cosmic-ray stations in Canada which have equipment maintained by AECL are given in tabular form for the period from the startup of the station to the end of

solar rotation No. 1812. The vectors have been corrected for barometer and in the case of the muons for the atmospheric temperature wave using hourly values of the temperature and barometric pressure measured near the ground. Graphs of the vectors at each station for successive solar rotations are also given. (auth)

12659 (N-70-10498) SOLAR AND GALACTIC COSMIC RAYS AND THE INTERPLANETARY MAGNETIC FIELD, JANUARY 28-FEBRUARY 25, 1967. Lindgren, Stig (Uppsala Univ. (Sweden)). [1969]. 14p. (NASA-CR-106636). CFSTI.

Solar and galactic particle fluxes after the January 28, 1967 particle flare are discussed in relation to interplanetary field observations. A soft pre-event began at 0214 on January 28. It shows modulation features carried by the solar wind from Explorer 33 to IMP-3. The interplanetary magnetic field shows a sudden, major change of direction in coincidence with the onset of the main event, which begins at 0835. New injections of energetic protons take place late on February 2 and 13. The enhanced diurnal variation seen by neutron monitors January 31-February 7 coincides well with a two-fold increase in the magnitude of the interplanetary magnetic field. Several hours before a magnetic storm at the end of this period, the interplanetary magnetic field appears to be strongly squeezed; it enters the ecliptic plane from below at a theta-angle of 60° and with a magnitude of 10 gammas. (auth) (Star)

12660 (N-70-11776) ON THE ANOMALOUS COMPONENT OF ATMOSPHERIC MUONS. Maeda, Kaichi (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Nov 1969. 10p. (NASA-TM-X-63740; X-641-69-491). CFSTI.

An alternate interpretation of the recent underground muon data is presented. This interpretation, which does not invoke an anomalous component of atmospheric muons produced by the so-called X process, attempts to resolve discrepancies existing between the previous and the latest Utah results, as well as those with data from the underground experiments at Kolar. (auth) (STAR)

12661 (N-70-11845) RADIAL GRADIENTS AND ANISOTROPIES OF COSMIC RAYS IN THE INTERPLANETARY MEDIUM. Fish, L. A.; Axford, W. I. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Nov 1969. 28p. (NASA-TM-X-63743; X-511-69-505). CFSTI.

Approximate equations which describe the behavior of cosmic rays in the interplanetary medium under suitable conditions are used to make comparisons between observations and theoretical predictions of radial anisotropies. In the high-energy region there appear to be no inconsistencies between theory and observations. In the low-energy region, it is shown that theoretical predictions of the radial anisotropy expected from large radial gradients of the intensity are not inconsistent with observed radial anisotropies. However, in the latter case there are other inconsistencies, which suggest that some aspects of the observations or of the theory (or both) are unsatisfactory. (auth) (STAR)

12662 COSMIC RAY PHYSICS. NUCLEAR AND ASTROPHYSICAL ASPECTS. Hayakawa, Satio. Interscience Monographs and Texts in Physics and Astronomy. Volume XXII. New York; John Wiley and Sons, Inc. (1969). 784p. $39.50.

The book begins with an historical introduction. The essential quantitative information is presented in a form that can be readily used. Although quantum theory and high-energy physics are needed for a thorough understanding, formulae, graphs, and tables may be used. A review and treatise on very high-energy interactions are given. The morphology of cosmic rays on Earth is described in textbook style, with the intention that the results will be used also for applications in other branches of science. The astrophysical aspect of cosmic rays is treated in detail. (W.D.M.)

12663 ELEMENTARY PROCESSES FOR COSMIC RAY ASTROPHYSICS. Ginzburg, V. L. Topics in Astrophysics and Space Physics. New York; Gordon and Breach, Science Publishers, Inc. (1969). 137p.

This book is based on a lecture course prepared in 1966 for the summer school at Les Houches. The text of the lectures is merely the English translation of the original Russian lectures with one topic added: Synchrotron Emission and Reabsorption. (W.D.M.)

12664 NEW POSSIBILITY OF EXPLAINING THE COMPLEX FORM OF THE ENERGY SPECTRUM OF ULTRAHIGH ENERGY PRIMARY COSMIC RAYS. Kulikov, G. V.; Fomin, Yu. A.; Khristiansen, G. B. (Moscow State Univ.). JETP Lett. (USSR) (Engl. Transl.); 10: 222-5(5 Oct 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu; 10: 347-53(5 Oct 1969).

A model is considered in which the cosmic rays are of purely galactic origin, and in which there exists, besides the stationary energy spectrum with integral exponent $\gamma = 1.7$, also a nonstationary component due to the explosion of the core of the Galaxy and having near the source the same exponent of the integral energy spectrum, $\gamma = 1.7$. (W.D.M.)

12665 TIME VARIATIONS OF THE PENETRATING COMPONENT OF COSMIC RADIATION AT 1280 mwe IN 1967 TO 1968. Regimbart, Robert; Scherer, Maurice (Univ., Caen, France). Compt. Rend., Ser. B; 269: 777-80(20 Oct 1969). (In French).

From a study of the time distribution of the penetrating component of cosmic radiation, the absence of solar and sidereal diurnal and semi-diurnal variations, the presence of a lunar semi-diurnal variation and an important monthly variation, as well as a 27-day effect were revealed. (tr-auth)

12666 DIFFUSE COSMIC X-RAY BACKGROUND FROM 20 TO 220 keV. Bleeker, J. A. M.; Deerenberg, A. J. M. (Kamerlingh Onnes Laboratorium, Leiden). Astrophys. J.; 159: 215-28 (Jan 1970).

Balloon experiments with identical x-ray detectors, carried out from three different geomagnetic latitudes ($\Lambda = 20°$, 40°, and 50°) resulted in an accurate determination of the energy spectrum of the diffuse cosmic x-ray background between 20 and 220 keV. The spectrum closely fits a single power law: $I(E)dE = 195E^{-2.45\pm0.10}dE$ photons sec^{-1} cm^{-2} $sterad^{-1}$ keV^{-1}. Thus it is concluded that the flattening of the spectrum observed at lower energies occurs below 20 keV, with a change in spectral index of one power. Extrapolation of the present results to the γ-ray region above 100 MeV yields a flux which is 1 order of magnitude lower than the isotropic flux of γ rays observed by Clark, Garmire, and Kraushaar in OSO-III. This suggests different mechanisms of origin for the isotropic flux of γ rays above 100 MeV and the background of cosmic x-rays. (auth)

12667 STUDY OF SOLAR MODULATION OF LOW-ENERGY COSMIC RAYS USING DIFFERENTIAL SPECTRA OF PROTONS, ^{3}He, AND ^{4}He AT E ≤ 100 MeV PER NUCLEON DURING THE QUIET TIME IN 1965 AND 1967. Hsieh, K. C. (Univ. of Chicago). Astrophys. J.; 159: 61-76(Jan 1970).

The differential spectra of galactic cosmic-ray protons, ^{3}He, and ^{4}He at energies between ~20 and 100 MeV per nucleon were measured during quiet periods between July and October, 1967. The differential spectra of ^{3}He and ^{4}He between 30 and 100 MeV per nucleon measured during solar minumum, May-September, 1965, were revised and compared with the results of higher-energy measurements made by balloon experiments. These satellite measurements, shown to be free of detectable solar contamination, are used for a study of solar modulation of low-energy cosmic rays. A simple diffusion-convection model with the diffusion coefficient having a functional form that is constant in time fails to explain the observations; however, the same model with the diffusion coefficient having a time-dependent functional form (e.g., Jokipii's extension of the model) can account for the observations. Further, it is found that a combined process of diffusion-convection and deceleration can also explain the observations. This latter alternative is more likely to be the appropriate model of modulation of low-energy cosmic rays. (auth)

12668 FREQUENCY SPECTRUM OF AIR SHOWER RADIO PULSES. Allan, H. R. (Imperial Coll. of Science and Tech., London); Clay, R. W.; Jones, J. K. Nature (London); 225: 253-4 (17 Jan 1970).

Measurements at 2 and 408 MHz on the radio emission from extensive air showers made at Haverah Park, combined with previous measurements at 32 and 44 MHz, allowed construction of a tentative frequency spectrum for the radiation. Measurements below 30 MHz are difficult because of the high level of background interference from terrestrial sources; this, however, is greatly reduced during daylight hours near 2 MHz as a result of D-layer absorption in the ionosphere. The frequency 408 MHz is protected for radio astronomy and has been used successfully for radio pulse work. Details are given of the equipment and technique employed. The rf waveform was amplified, delayed, and then displayed directly on an oscilloscope, the timebase of which was triggered, and a photograph taken, whenever the particle array recorded an air shower of energy $\geq 10^{17}$ eV. There was no obvious increase in the rf amplitude at the time of arrival of a shower. An analysis was performed on the records of 400 showers, and it was concluded that radio emission was observed at 2 MHz from air showers of energy $\geq 10^{17}$ eV. The typical radio pulse amplitude at the receiver terminals was 300 μV, and the corresponding vertical component of the incident rf field was 300 μV/m/MHz. The results are compared with the earlier measurements on showers of the same size at 32 and 44 MHz. Some compari-

sons are also made with Jodrell Bank measurements, made with a high-gain radioastronomy antenna and parametric receiver. (UK)

Direct Energy Conversion

12669 (GA–9465) THERMAL STABILITY TESTING OF AN ELECTRICALLY LOADED SHEATH INSULATOR. Chin, J.; Messick, C. W. (Gulf General Atomic, Inc., San Diego, Calif.). Oct 1969. Contract AT(04-3)-167. 16p. (CONF-691024–3). Dep. CFSTI.

From IEEE Thermionic Conversion Specialist Conference, Carmel, Calif.

Thermal stability testing of a trilayer niobium/alumina/niobium sheath insulator at 1200°C with 100 volts impressed across the ceramic is described. Resistance measurements across the sheath insulator increased from 33 kilohms to 1.68 megohms during a 5313-hour test. Preferential diffusion of alumina was detected in the inner niobium ring. Grain boundaries in the alumina layer became prominent. Density changes in the alumina layer were apparent. Metallographic, microhardness, and microprobe results are presented. A plasma-sprayed alumina coating applied to the end of the test sample survived the thermal stability test without spalling. (auth)

12670 (IAE–1810) THERMIONIC SOURCE OF LITHIUM GLASS. Gurevich, A. I.; Kucheryaev, Yu. A.; Nikolaenko, V. S. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1969. 28p. (In Russian). Dep. CFSTI (U. S. Sales Only).

A thermionic source is described, whose emitter is a layer of lithium aluminosilicate glass (synthetic beta-eucryptite) deposited on the surface of a molybdenum core of 10-mm diameter. A cermet triode (GS-9B) circuit is used in the source. Results are given of measured total current and the emission components. At a temperature of 1250°C, the ionic current reaches 6 mka, and together with isotopes of $^6Li^+$ and $^7Li^+$, ions of Na^+ and K^+ are emitted. The magnitude of the current of each component and their relations depend on the emitter temperature. The source of alkali ions described is comparatively better than sources having surface ionization and is useful in solving many problems in experimental physics. (tr-auth)

12671 (SC-DC–64-442) THERMIONIC GENERATOR FOR RE-ENTRY VEHICLES. LeBlanc, Andre; Grannemann, W. W. (New Mexico Univ., Albuquerque. Dept. of Electrical Engineering). Feb 1963. 39p. Dep. CFSTI.

For Sandia Corp., Albuquerque, N. Mex.

A novel design of a thermionic generator for use on reentry vehicles is analyzed analytically and experimentally. Equations are derived for prediction of the output current, output power, and conditions of maximum power for the device. The electrical power output potential of a typical reentry vehicle is obtained by solving the temperature history of a thin-walled emitter. Given the wall temperature and the work function, the saturated Richardson current is easily obtained. Other parameters needed for predicting output power are obtained from curves in the literature. To simulate reentry conditions, a test model was built and inserted in either a nitrogen or argon plasma jet. Graphite, thoriated tungsten, tungsten, and molybdenum were used for the emitter and collector. Of the materials tested, graphite was the only material that met, to some degree, the qualifications needed for operation of the hypersonic plasma thermionic generator. (auth)

12672 EFFECTS OF TURBULENCE ON THE PERFORMANCE OF THE NONEQUILIBRIUM MAGNETOHYDRODYNAMIC POWER GENERATOR. Miyata, Masahiko; Iiyoshi, Atsuo (Keio Univ., Tokyo). Proc. Fujihara Mem. Fac. Eng., Keio Univ. (Tokyo); 21: 118–27(Sep 1969).

A turbulence due to the ionization instability affects the performance of the nonequilibrium MHD power generator through reductions of an effective Hall parameter and conductivity. The Fourier analysis of the electron continuity equation and the electron momentum equation gives the mean current density and the electric field. The mean current density and electric field contain the anomalous terms due to turbulence. The generalized Ohm's law thus obtained gives an effective Hall parameter and an effective conductivity. These parameters decrease as the fluctuation intensity $S = 4\pi \int_0^\infty (|n_{ek}/n_{e0}|)^2 k^2 dk$ increases. In the case of a sinusoidal wave disturbance ($S = 0.5$), the Hall parameter is nearly $\pi/8$ and the effective conductivity is 1/5 times the normal conductivity. Experimental results obtained in the small scale MHD generator are well explained by the present theory when the parameter S is assumed to be proportional to the ratio of the temperature of the electron to that of the gas. (NSA of Japan)

12673 CERAMIC COMPONENT FOR ELECTRODES. Anthony, Anne-marie; Foex, Marc; Yerouchalmi, David (to Commissariat a l'Energie Atomique). British Patent 1,179,525. 28 Jan 1970. Priority date 8 Feb 1968, France.

A ceramic material is described for use in high-temperature MHD electrodes. It comprises a solid solution of a rare-earth chromite, an excellent conductor, mixed with a perovskite-type oxide for lowering the volatility of the chromite. The oxide may be a rare-earth aluminate, or a zirconate, hafnate, titanate, or stannate of an alkaline-earth metal. An example of the material is $LaCrO_3$ mixed with $SrZrO_3$. Methods for varying the composition of layers in electrodes of this material for optimum MHD performance are also described. (D.L.C.)

Fluid Physics

12674 FLOW OF ELECTRICALLY CONDUCTING VISCOUS FLUIDS AROUND THIN PROFILES. PART I. Marcov, N. (Univ. of Bucharest). Stud. Cercet. Mat.; 20: 199–211(1969). (In Rumanian).

Following up earlier studies on the magnetohydrodynamic flow of viscous, incompressible and electrically conducting fluids around a flat plate by Oseen's method using Fourier transforms, the plane motion around a thin profile was examined. It was assumed thereby that the flow of the fluid at infinity is parallel with the magnetic field. The nonlinear equations were linearized, expressing the current and force functions on the basis of a harmonic function by a specific application of the three-dimensional case. An integral equation was obtained; the current and force functions were represented by potentials. The problems may be solved by handling a Fredholm-type equation. The approximate solution for the case of an ellipsoidal arc shaped profile was presented for flow at low Reynolds numbers. (TTT)

12675 CYLINDRICAL SHOCK AND DETONATION WAVES IN MAGNETOGASDYNAMICS. Christer, A. H. (Univ. Strathclyde, Glasgow); Helliwell, J. B. J. Fluid Mech.; 39: 705–25 (15 Dec 1969).

Self-similar flow patterns are studied which arise when a cylindrically symmetric strong shock or detonation wave propagates outwards into a gas at rest in which the ambient density varies as the inverse square of the distance from the axis of symmetry along which flows a line current of either zero or finite constant strength. The electrical conductivity of the gas on either side of the wave is supposed perfect and the discontinuities discussed are either gasdynamic or magnetogasdynamic in nature. It is shown that self-similar solutions exist for piston driven gasdynamic detonation and shock waves. While no self-similar solutions may occur for magnetogasdynamic detonation waves, it is demonstrated that magnetogasdynamic shock waves do possess such solutions for which detailed flow patterns are presented. (auth)

12676 SUBSTITUTION PRINCIPLES IN NONSTEADY MAGNETOGASDYNAMICS. Power, G.; Rogers, C. (Univ. of Nottingham, Eng.). Appl. Sci. Res. (The Hague); 21: 176–84(Oct 1969).

General substitution principles are established in nonsteady magnetogasdynamics. The theorems presented include previous results as particular cases. A class of nonsteady magnetic substitute flows is constructed. (auth)

12677 UNSTEADY MAGNETOHYDRODYNAMIC FLOW AT THE FORWARD STAGNATION POINT. Katagiri, Masakazu (Yamagata Univ., Japan). J. Phys. Soc. Jap.; 27: 1662–8(Dec 1969).

The unsteady flow of an electrically conducting fluid, impulsively brought in motion with a constant velocity from rest at the forward stagnation point of an infinite plane wall which is an electric insulator, is considered. When a magnetic field is applied normal to the wall, its effects on the transient phenomena to the steady flow case are studied by a usual unsteady approach. The derived fundamental equation on the assumption of small magnetic Reynolds number is solved both by an expansion method into power series and by a numerical method employing the difference–differential method. Solutions obtained by series expansion method are found to be invalid for large times. On the other hand, the difference–differential method may present well behaved solutions for the transition region in the flow impulsively started from rest and those of steady flow. Numerical results are given for the velocity profile, skin friction and time required to attain a value of skin friction within 0.1% of that of steady flow case. (auth)

12678 A ROTATING FIELD MHD HYDROSTATIC THRUST BEARING. Chow, Chuen-yen (Univ. of Colorado, Boulder);

Brunell, R. D. Appl. Sci. Res. (The Hague); 21: 206-17(Oct 1969).

It is found that the load capacity of a magnetohydrodynamic thrust bearing with a rotating disk can be increased by rotating the axial magnetic field at a suitable speed in a direction opposite to that of the disk rotation. This method of improving the bearing performance is considered to be efficient if the Hartmann number is not too large. Thus for a given load, the size and weight of the magnet to be used in a thrust bearing with rotating field can be reduced considerably. (auth)

12679 ONE-DIMENSIONAL FLOW IN ELECTROHYDRODYNAMICS. Gogosov, V. V.; Polyanskii, V. A.; Semenova, I. P.; Yakubenko, A. E. Prikl. Mat. Mekh.; 33: 232-9(Mar-Apr 1969). (In Russian).

The one-dimensional, stationary electrohydrodynamic motion of a conducting medium containing a charged and a neutral component is investigated. The motion of the medium is due to the volume charge and its interaction with the electric field. Two special cases are examined in detail: in the first case it was assumed that the parameter Q was small, Q being defined as being equal to $4\pi q_0 L/E_0$, whereby q_0 is the volume electric charge, L the characteristic length and E the electric field potential. In that case the electric field has a preassigned value. A general solution is obtained for the constant field E_0. Integral curves plotted in the velocity–Mach number plane allows determination of the nature of the flow on the basis of known velocity and Mach number values. The second situation involves cases with an arbitrary value of Q, i.e., flow in an alternating electric field. The stability of the passage through the sound barrier is examined by means of the fundamental equations of the one-dimensional flow. (TTT)

12680 ELECTROCONVECTIVE INSTABILITY IN A FLUID LAYER. Jolly, D. C.; Melcher, J. R. (Massachusetts Inst. of Tech., Cambridge). Proc. Roy. Soc. (London), Ser. A; 314: 269-83(6 Jan 1970).

Steady flows of a fluid of slight electric conductivity under the influence of an applied electric field intensity are often unstable. A study is described to illustrate with experiments and an analytical model the fundamental aspects of a wide range of instabilities that are characterized by the incipience of steady cellular convection as the electric Hartmann number $Ha_e = \epsilon E/\sqrt{(\mu\sigma)}$ is of the order of unity (ϵ is the permittivity, E the imposed electric field intensity, μ the viscosity, and σ the electrical conductivity). A nonuniform electric field is used to induce an unstable configuration of surface charge and electric field intensity at a planar interface. The resulting instability leads to cellular convection in the plane of the interface. Predictions of the electric Hartmann number and wavelength for incipience of instability compare favourably to measurements. The dependence of the measured cellular convection velocity, resulting from the instability, on electric Hartmann number and electric Reynolds number are also in satisfactory agreement with the predictions from the simple model. (auth) (UK)

12681 MAGNETOHYDRODYNAMIC FREE CONVECTION IN A STRONG CROSS FIELD. Kuiken, H. K. (Univ. of British Columbia, Vancouver). J. Fluid Mech.; 40: 21-38(14 Jan 1970).

The problem of magnetohydrodynamic free convection of an electrically conducting fluid in a strong cross field is investigated. It is solved by using a singular perturbation technique. The solutions presented cover the range of Prandtl numbers from zero to order one. This includes both the important cases of liquid metals and ionized gases. A general examination is given of the role of the important parameters: Hartmann, Grashof and Prandtl numbers of the problem. This provides clear insight into its singular character and yields the correct expansion parameters. The boundary-layer approximations are derived from the complete Navier–Stokes and energy equations. The conditions for these approximations to be valid will be explicitly stated. Attention is given to "power law" wall-temperatures and magnetic fields, and an assessment is given of the range of application. (auth) (UK)

Geophysics (Upper Atmosphere)

Refer also to abstracts 12544, 12579, and 12874.

12682 (AD-486729) FARADAY ROTATION MEASUREMENTS OF ELECTRON CONTENT NEAR THE MAGNETIC EQUATOR, USING THE TRANSIT IV-A SATELLITE. Special Technical Report No. 14. Ruffenach, Clifford L.; Nimit, Vichai T.; Leo, Robert E. (Stanford Research Inst., Menlo Park, Calif.). Jan 1966. Contract DA-36-039-AMC-00040(E). 62p. CFSTI.

At the Electronics Laboratory of the Military Research and Development Center, Bangkok, Thailand, Faraday rotation observations of the 54-MHz signal from the Transit IV-A (1961 OMICRON I) Satellite were made during ten months of a sunspot minimum period (1964). (auth) (USGRDR)

12683 (AD-695520) CHARACTERISTICS OF AURORAL PARTICLE FLUX. Phillips, Kenneth E. (Utah Univ., Salt Lake City. Upper Air Research Lab.). Apr 1969. Contract F19628-67-C-0275. 230p. (UU-69-4). CFSTI.

An auroral experiment, utilizing a rocket payload (Aerobee 3.615), provided direct "in situ" measurements of the primary auroral flux precipitated during the breakup phase of a medium-intensity IBC II auroral event above Churchill Research Range, Manitoba, Canada on December 14, 1966. The rocket payload included instrumentation for determining both the number densities of the proton and electron flux and the total energy carried by the particles. The bright auroral displays, manifest in the all-sky camera photographs, occurred usually some distance from the rocket; the region surrounding the rocket being usually characterized by only dim-diffuse auroral displays. However, when the rocket was at an altitude of 130 km on the descent portion of the flight, a bright auroral arc quickly developed in the immediate vicinity of the rocket. The rocket's penetration of this bright arc was marked by rapid increases in the particle flux measurements; the energy flux and number densities increased by a factor of ten. (auth) (USGRDR)

12684 (AD-696070) A SURVEY OF LOW-ENERGY (E GREATER THAN OR APPROXIMATELY EQUAL TO 5 keV) ELECTRON ENERGY FLUXES OVER THE NORTHERN AURORAL REGIONS WITH SATELLITE INJUN 4. Craven, John D. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Jul 1969. Contract Nonr-1509(06). 66p. CFSTI.

Observations of the energy fluxes $\gtrsim$5-keV electrons at low altitudes (~525 to 2500 km) over the northern auroral regions have been made by the nearly polar-orbiting Injun 4 satellite, from February 1965, through July 1966, during a period of minimum solar activity. Results of the first detailed survey of the percentages of occurrence of the energy fluxes $\gtrsim$5-keV electrons (with pitch angles ~40° ± 15°) in the outer radiation/auroral zone, as a function of magnetic local time and invariant latitude, are graphically displayed for various energy flux thresholds. The greatest occurrences of these energy fluxes were observed in the night–dawn–morning hours of local time, at latitudes from ~65 to 70°, with median energy fluxes as great as 0.1 ergs/cm^2-sec-sr^{-1}. The spatial distributions of these contours are compared with those for the occurrences of optical auroras. Limited simultaneous observations of these energy fluxes at pitch angles of ~40 and 90° have shown that the ratios of these energy fluxes are typically greater than 0.1, with a condition of isotropy occurring for energy fluxes $\gtrsim$1 erg/cm^2-sec-sr^{-1}. (auth) (USGRDR)

12685 (AD-696071) FURTHER COMMENTS CONCERNING LOW-ENERGY CHARGED PARTICLE DISTRIBUTIONS WITHIN THE EARTH'S MAGNETOSPHERE AND ITS ENVIRONS. Frank, L. A. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Jul 1969. Contracts Nonr-1509(06); NAS5-9074. 37p. CFSTI.

Several recent observations of the distribution of low-energy charged particles (100 eV < E < 50 keV) within the Earth's magnetosphere and its environs were examined for evidences of source (acceleration) mechanisms. Proton (0.5 < E < 50 keV) intensities in the outer radiation zone and plasma sheet are concentrated on, since this population forms the largest charged-particle energy reservoir in the magnetospheric system. No source mechanism for these proton intensities with broad differential energy spectrums (i.e., of the plasma sheet and the storm-time and quiescent "ring currents") has been clearly delineated. It is suggested herein at least the storm-time ring current protons are of solar origin and are convected into the magnetotail under the influence of magnetospheric electrostatic fields or via a diffusion process driven by fluctuating magnetic and/or electric fields. (auth) (USGRDR)

12686 (N-69-40113) THE TOPSIDE IONOSPHERE OF VENUS AND ITS INTERACTION WITH THE SOLAR WIND. Bauer, S. J.; Hartle, R. E.; Herman, J. R. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Oct 1969. 10p. (NASA-TM-X-63717; X-615-69-459). CFSTI.

The abrupt termination of the daytime ionosphere of Venus at about 500 km was observed using the Mariner 5 two-frequency occultation experiment for direct solar-wind interaction with a planetary ionosphere. A pseudo-magnetopause formed due to the presence of magnetic fields carried along by the solar wind and forced to pile up on the topside of the highly conducting planetary ionosphere is proposed. Solar wind properties are used to calculate order-of-magnitude estimates of the characterized parameters. A range of possible models satisfying the experimental boundary conditions is being investigated in some detail. (auth) (STAR)

12687 (N-70-10723) ION COMPOSITION AND ION CHEMISTRY IN AN AURORA. Donohue, T. M.; Zipf, E. C. Jr.; Parkinson, T. D. (Pittsburgh Univ., Pa. Space Research Coordination Center). 23 Jul 1969. Contracts NASR-179; DA-31-124-ARO(D)-440. 40p. (NASA-CR-106649; SRCC-99). CFSTI.

Ion composition measurements are reported as obtained with a rocketborne mass spectrometer flown during an aurora. At the level of highest ion production near 115 km the NO^+ density was a factor of 3 larger and the O_2^+ density, a factor of 10 smaller than expected from normal composition, temperature and ion chemistry models. The O^+ density was a factor of 50 larger than expected. The results appear to demand effective ion temperatures greater than 1000°K and electron temperatures even larger. They also require efficient channels for conversion of O_2^+ to NO^+. Reactions of O_2^+ with anomalously abundant NO or N with vibrationally excited N_2 are regarded as possible modes for transforming O_2^+ into NO^+. Densities of He^+ in excess of 50/cm^3 were observed and not understood. The O_2^+ densities measured are too low to permit dissociative recombination to contribute significantly to O 1 green line excitation except at high altitude. (auth) (STAR)

12688 (N-70-11028) PARTICLE DETECTION EXPERIMENT FOR APPLICATIONS TECHNOLOGY SATELLITE 1 (ATS-1). Final Report. Augustyniak, W. M.; Hayashi, I.; Kern, H. E.; Kerr, R. W.; Lanzerotti, L. J.; (and others) (Bell Telephone Labs., Murray Hill, N. J.). 1 May 1969. Contract NAS5-9635. 273p. (NASA-CR-106637). CFSTI.

For Western Electric Co., Inc., New York.

The experiment on ATS-B was designed to measure the energy spectra of electrons and protons at the synchronous satellite altitude in order to study the systematic day-night variations in the trapped particles arising from the distortion of the Earth's magnetic field by the magnetospheric boundary with the solar wind, the perturbations in the trapping associated with magnetic storms, and the long-term changes in the particles during the time of increasing solar activity. The telescope provides spectral information for electrons in the 0.4- to 3-MeV energy range and for protons in the 0.6- to 22-MeV energy range. The experiment also permits investigation of the possible existence of alpha particles within the magnetosphere in the energy range from approximately 6 to 85 MeV. (auth) (Star)

12689 (N-70-11232) MeV PARTICLES IN THE OUTER ZONE: EXPLORER 12. Kaufmann, Richard L.; Konradi, Andrei (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center. New Hampshire Univ., Durham). Feb 1969. 31p. (NASA-TM-X-62507; UNH-R-69-5). CFSTI.

Fluxes of 100-keV electrons and protons on high L shells are compared with fluxes of more energetic particles in the heart of the outer zone. A number of characteristics of the changes in these fluxes are noted and compared with predictions of several models of particle acceleration and energy transport. It is concluded that two separate mechanisms are required to produce MeV protons in the heart of the outer zone. Protons must first be accelerated to several hundred kilovolts on or above the highest closed drift shells. Several pumping mechanisms that can do this are discussed. Diffusion in which the first adiabatic invariant is conserved can then transport these protons to the heart of the outer zone and further accelerate them to the MeV energy range. A convection system and its associated electric fields contain enough energy to drive the diffusion. Electrons can undergo a similar acceleration process. (auth) (STAR)

12690 (N-70-11247) PIONEER 6 PLASMA MEASUREMENTS IN MAGNETOSHEATH. Howe, Herbert C. Jr. (Massachusetts Inst. of Tech., Cambridge. Center for Space Research). Jun 1969. 29p. (NASA-CR-106735; CSR-P-16). CFSTI.

Measurements of the magnetosheath plasma made during the outbound passage of Pioneer 6 in the dusk meridian are presented and compared with theoretical predictions for the same region. While the comparison indicates that the plasma flow around the Earth agrees in many ways with a gas dynamic model, observed discrepancies in the density ratio across the bow shock and the non-Maxwellian velocity distribution in the magnetosheath warrant further explanation. Magnetosphere and magnetosheath low-energy electron measurements indicate a region of anisotropic flux in the magnetosphere near the magnetopause. (auth) (Star)

12691 (N-70-11777) STUDY OF THE THERMAL PLASMA ON CLOSED FIELD LINES OUTSIDE THE PLASMASPHERE. Mayr, H. G.; Grebowsky, J. M.; Taylor, H. A. Jr. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Jul 1969. 31p. (NASA-TM-X-63736; X-621-69-299). CFSTI.

Using OGO 4 ion composition measurements near the mid-latitude light ion trough below 1000 kilometers, a model for the plasma state along the magnetic field lines is developed. It produces, in the equatorial plane, the sharp density gradient characteristic of the plasmapause. In this model the field aligned plasmasphere boundary is a boundary across which the characteristics of the proton flux along the field lines change. Within the plasmasphere the proton fluxes along the field lines are of small or vanishing magnitude and may be directed either away from or towards the Earth. By contrast, the small equatorial ion densities known to exist on closed field lines outside the plasmasphere are consistent with the measured low altitude densities only if large proton fluxes, of the order of the critical flux, are directed along the field lines. These latter fluxes are directed away from the Earth and correspond to the attainment of supersonic proton flow velocities on closed field lines outside the plasmasphere. This is consistent with the model of a supersonic polar wind convecting onto closed field lines. (auth) (STAR)

12692 (N-70-12274) BEHAVIOR PATTERNS OF ARTIFICIAL ION CLOUDS IN THE IONOSPHERE AND THE MAGNETOSPHERE. Scholer, Manfred. Translated from a German dissertation. 111p. (NASA-TT-F-12565). CFSTI.

The ambipolar diffusion of a cylindrical symmetric plasma cloud in a slightly ionized background with a homogeneous magnetic field is examined. The assumption is made that no exterior electric field is adherent, and no differentiation is drawn between the ions of the cloud and the ions of the background. The diffusion parallel to the magnetic field is studied as a special dimensional problem in this context. In addition, the deceleration process of an ionized cloud moving relative to magnetosphere plasma is investigated and it is shown that alternation of the tubular flow through the cloud in connection with the ionosphere is important for the deceleration process. The possible occurrence of instabilities during cloud movements is discussed. Equations of motion and continuity and Maxwell equations are used to obtain the basic differential equation for the diffusion problem. This equation is linearized and, with the simulated density distribution, numerically integrated for potential determinations. A magnetohydrodynamic model is developed for the analysis of cloud kinetics and the effective conductivity of the ionosphere. (STAR)

12693 GEOMAGNETIC EFFECTS OF NUCLEAR EXPLOSIONS IN THE LOW ATMOSPHERE. Ferrieux, Henri (Bureau de Documentation, Hauts-de-Seine, France). Compt. Rend., Ser. B; 269: 659-60(6 Oct 1969). (In French).

The magnetic effect due to the expansion of the plasma, forming a fireball in the terrestrial magnetic field, is in conformance with what is anticipated by the theory. In particular, its amplitude is a linear function of the energy liberated by the explosion. (tr-auth)

12694 ON SOME PROBLEMS OF THE LAYER FORMATIONS IN THE INTERMEDIATE E-F REGION. Serafimov, Kiril. Izv. Geofiz. Inst., Bulg. Akad. Nauk.; 14: 87-102(1969). (In Russian).

Additional data about the daytime variations are considered. The seasonal variations of the maximal electron concentration of the E2 layer (N_mE2) are analyzed. By applying the method of the author the variations of the effective recombination coefficient in the E2 layer are $5 \times 10^{-9} \leq \alpha_{eff} E2 \leq 5 \times 10^{-8}$ cm^3 s^{-1}. On the basis of this coefficient and the known changes of the ionization index J_{g2} the possibility of E2 layer formation by the Bradbury mechanism is rejected and the independent source of this layer is confirmed. The basic regularities and some problems about the F0 layer origin are considered. In particular the daytime, seasonal and cyclic variations of the probability for this layer's appearance and its maximal electron concentration are studied. The most frequently met continuance of an incessant existence of the F0 layer coincides approximately with the most repeated period of the quasi-periodic fluctuations in the ionosphere, and with this the significant influence of the dynamical processes on this layer formation is established. (auth)

12695 NIGHT TIME IONOSPHERIC ABSORPTION AT MEDIUM SOLAR ACTIVITY. Nestorov, Georgi. Izv. Geofiz. Inst., Bulg. Akad. Nauk.; 14: 63-73(1969). (In Russian).

Two frequency ranges are defined corresponding to two different mechanisms in the nighttime radiowave propagation; in the first range fall signals that reflect in the nighttime E layer, resp. E_s, and in the second one—signals, that reflect in the F region; the approximate frequency boundary between the two ranges is 0.6 to 0.7 MHz, and the mean height of reflection—120 km. An explanation is offered about the specific seasonal course of the absorption at three different frequencies. In the period of equinox the absorption absolute value for frequencies from the two ranges is practically the same, while for signals from the first range a strongly expressed summer maximum exists, and for signals of the second range—a summer minimum. The summer as well as the winter increases of the absorption are explained by the nighttime E layer

thickening, and the summer decrease of the absorption for frequencies of the second range—with the abundance of sporadic layers during this season. Not every signal frequency is suitable to find the relations between absorption and the geomagnetic activity; for signals that reflect in the near-maximum part of the nighttime E layer, the absorption increases with the geomagnetic activity increasing; this relation is found only for ρ reading referring to the interval 50 to 60 hours after the K-index readings. The dephasing of the ionospheric effects from the geomagnetic ones with more than two days confirms the supposition about the accelerating processes existing in the magnetosphere in the reverse phase of the geomagnetic disturbance. (auth)

12696 EFFECTS IN NIGHT TIME LOWER IONOSPHERE AT MIDDLE LATITUDES CAUSED BY SOLAR CORPUSCULAR FLUXES. Nestorov, Georgi. Izv. Geofiz. Inst., Bulg. Akad. Nauk.; 14: 53-61(1969). (In Russian).

Through measurement of the nighttime ionospheric absorption at an equivalent frequency 0.5 MHz, an additional ionization is established at a height 100 to 110 km caused by solar corpuscular fluxes at a geomagnetic latitude 42°. During the main phase of the geomagnetic storm the absorption increases, but in the reverse phase it is about 6 db higher than the first one. The second maximum appears 2 days after the day of the geomagnetic storm and coincides with the middle of the recovering period of the geomagnetic field. This result is explained by the similarity of the accelerating processes in the magnetosphere in the main and reverse phase of the storm. The absorption obtains its normal value about the fourth day after SSC. Two days before SSC a presage of the geomagnetic storm is noticed. The absorption increase is explained by the nighttime E-layer lower part decrease in a region with a significantly higher collisional frequency and is in accordance with the data from rocket measurements of the electronic concentration in the E layer. (auth)

12697 ON THE CHANGES IN THE F1 LAYER DEPENDENCY ON THE SOLAR ZENITH ANGLE AND THE POSSIBILITIES FOR DISTINCTION OF α AND β NEUTRALIZATION. Serafimov, Kiril. Izv. Geofiz. Inst., Bulg. Akad. Nauk.; 14: 75-84(1969). (In Russian).

The full expressions about the exponent in the cosine dependency of the F1 layer in nonisothermal environment are considered. At α and β neutralization, significant changes in this exponent should be obtained, but when giving an account of the daytime variations in the molecular concentration it is proved that, from the changes in nF1, one cannot judge precisely about the character of deionization. The availability of neutralization of a mixed $\alpha-\beta$ type leads to a general decrease in the value of nF1. The observation data from 14 stations in the period 1957–1966 independently on their significant dispersion show the following: an outlined daytime asymmetry is apparent (the after-culmination values are usually larger than those before the culmination). The deviations in comparison with the cosine dependency on the solar zenith angle are most significant in winter, especially increasing at high solar activity when in a great part of the stations the bifurcation disappears; the impediment before culmination in the growth of f_0F1 corresponds to this one in the respective f_0E variations and is assigned to the dynamical influences; the values of the exponent nF1 systematically smaller than 1 with which the theoretical ideas developed in the work are confirmed; the exponent nF1 is diminished with the solar activity decrease. The nF1 maximum is in 1958. The variations obtained in nF1 are reasonable since with the solar activity decrease the temperature gradient decreases (at a minimal activity the gradient is approximately zero). (auth)

12698 SOME RESULTS OF THE COMPUTATION OF N(h) PROFILES OVER SOFIA. Gorinov, Nedko. Izv. Geofiz. Inst., Bulg. Akad. Nauk.; 14: 103-10(1969). (In Russian).

From data of the vertical soundings for October 1964 at the Sofia Ionospheric Station N(h) profiles were obtained. The profiles were calculated on a computer according to the method and algorithm described. The values for the electron concentration N obtained in the maximum part of the F2 layer correspond to the N values obtained by means of direct measurements (satellite and rockets). The existence of a daytime asymmetry in the F region is demonstrated at fixed heights in years with minimum solar activity. (auth)

12699 EXCITATION OF LONGITUDINAL WAVES BY THE EQUATORIAL ELECTROJET. Kamenetskaya, G. Kh. (Gorky State Univ., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 282-5(1969).

Translated from Geomagn. Aeron.; 9: 351-2(1969).

It was demonstrated by Farley (1963) that the two-stream instability of plasma may be responsible for the appearance of inhomogeneities in the equatorial electrojet. But solutions of initial kinetic equations with the collision term of Bhatnagar, Gross, and Krook (1954) were obtained by Farley only by the numerical method. A simplified, quasi-hydrodynamic approach was used by Kamenetskaya (1967), which made it possible to obtain the phase velocities and growth increments of relatively long waves in analytical form, while kinetic computations were performed without allowance for collisions. The solutions of the equations used by Farley are found in this note. These solutions refine the quasi-hydrodynamic solution by Kamenetskaya and limit the spectrum of the excited short-wave inhomogeneities. (W.D.M.)

12700 SOME PROBLEMS OF THE EARTH'S MAGNETOSPHERE PHYSICS. Ershkovich, A. I.; Skuridin, G. A.; Shalimov, V. P. (Inst. of Space Research, Moscow). Space Sci. Rev.; 10: 262-90(Nov 1969).

In the last few years a number of review papers devoted to various problems of magnetosphere physics have been published. In this review various formulations of the problem of the solar plasma flow around the Earth and calculated models of the magnetosphere are dealt with. The ring-current problem and charged-particle behavior during magnetic storms are considered along with the energetics of the most important geophysical phenomena, as well as some ways of transferring the solar-wind power inside the magnetosphere. Some feasible experiments in outer space are discussed. (W.D.M.)

12701 SIMULATION OF PLASMA IN THE IONOSPHERE AND THE MAGNETOSPHERE. Kiyama, Hiroko; Kiyama, Satoru; Ogawa, Kiyoshi; Tamaru, Takeshi. Denki Shikensho Iho; 33: 905-23(1969). (In Japanese).

Plasma in the ionosphere and the magnetosphere is simulated by using the simulation law in a cylindrical chamber which is 80 cm in length and 30 cm in diameter. The very quiescent steady plasma is made in various low-pressure gases (10^{-1} to 10^{-3} torr). The electron temperature of the plasma is low (3000°K) and the plasma density is variable over a wide range (10^{4} to $10^{11}/cm^3$). Especially the very high density ($10^{11}/cm^3$) and low temperature (2000°K) plasma can be made, in which the electron–ion collision is dominant. Probe and microwave measurements in the above-mentioned plasma and the mechanism of the plasma production are also discussed. (auth)

12702 DECREASE IN INTENSITY OF [OI] 6300 A AIRGLOW TOWARD DAWN. Okuda, Mitsunao (Hirosaki Univ., Japan); Misawa, Kiyotoshi. Rep. Ionosphere Space Res. Jap.; 23: 228-31 (1969).

It has been reported by a number of workers that the 6300 Å airglow shows a distinct predawn enhancement in winter at several stations in the northern hemisphere. However, all the observations hitherto carried out have been discontinued soon after the predawn enhancement, when the enhancement rate begins to decrease. In order to investigate the predawn enhancement and its final consequence in detail, the authors continued the observations after dawn, until the airglow intensity is affected by the scattered solar radiation. (W.D.M.)

12703 POLEWARD TRAVEL OF ELECTRIC CURRENT FILAMENT IN THE POLAR CAP REGION. Oguti, Takasi Tokyo Univ.). Rep. Ionosphere Space Res. Jap.; 23: 175-84(1969).

"Magnetic spikes," which appear in the region from the auroral zone to 80° geomagnetic latitude from 18h to 24h in local geomagnetic time, were investigated. It is concluded that the spikes are attributable to the poleward shift of very narrow westward electric current filament. It is also concluded that the magnetic disturbance starts in the noon high latitudes 20 to 30 minutes before the appearance of the current filament in the midnight auroral zone. (auth)

12704 MICROSTRUCTURE OF AURORAL-ZONE ELECTROJET. Kamide, Yohsuke; Iijima, Takesi; Fukushima, Naoshi (Tokyo Univ.). Rep. Ionosphere Space Res. Jap.; 23: 185-208 (1969).

Spatial structure and dynamical behavior of electrojets along the auroral zone or oval are studied by means of worldwide geomagnetic data during IGY, IQSY, and recent periods. Geomagnetic variation due to the auroral-zone electrojet contains short-period variations of several minutes. These high-frequency variations are associated with noticeable changes in the luminosity and/or the location of auroral arcs. Though the auroral-zone electrojet flows with the latitudinal width of about 1,000 km at the developing stage of geomagnetic bays, it does not develop uniformly, because the coherence of high-frequency variation at a N–S chain of stations is extremely poor. In the E–W direction, the auroral-zone electrojet extends about 10,000 km or more along the auroral oval, and not along the so-called auroral zone. The auroral oval coincides with the auroral zone at 1 to 2h in

local time. It is quite common that, in the evening sector, a sharp negative bay is observed on the polar side of the auroral zone, while a broad positive bay of smaller magnitude is observed at the auroral-zone station. Though the similarity and simultaneity of auroral-zone electrojets generally hold at the conjugate areas in the northern and southern hemispheres, the short-period component of disturbing field shows a poor coherence. (auth)

12705 ELEVENTH SOVIET ANTARCTIC EXPEDITION. Dubrovin, L. I. (Arctic and Antarctic Scientific Research Inst., Mirny, Antarctica). Sov. Antarct. Exped. Inform. Bull. (Engl. Transl.); 7: 1-4(Oct 1969).

Some scientific observations by the Eleventh Soviet Antarctic Expedition which are mentioned include: geomagnetic observations (absolute measurements, continuous recording of magnetic field variations, and experimental work with an underwater magnetometer); ionospheric observations (vertical sound and measurement of radio wave absorption by the pulse method continuous recording of absorption by riometer); radio comparison (continuous registration of radio station signals with recorders, measurement of field strength at ground radio stations, and radio station monitoring); cosmic-ray observations with ground-based equipment; recording of cosmic rays in the stratosphere; auroral observations (all-sky photography, photography of the spectrum, radar observations, and visual observations); magnetospheric investigations; study of the forward scattering of vhf; measurement of radio-wave absorption by recording the cosmic-noise level; whistler recording; and recording of short-period magnetic field pulsations. Magnetic activity was weak, even compared with the preceding year, which belonged to the IQSY period. Only half as many magnetic storms were recorded in 1966. The maximum amplitudes of the disturbances (particularly declination) were also considerably lower. (BBB)

12706 SPATIAL EXTENT OF THE RETURN CURRENT OF THE AURORAL-ZONE ELECTROJET. PART I. Fukushima, Naoshi (Tokyo Univ.). Rep. Ionosphere Space Res. Jap.; 23: 209-18(1969).

The intense westward electrojet along the auroral zone and its return currents in the surrounding regions constitute fundamentally the equivalent ionospheric current system for polar elementary magnetic storms in high latitudes. A quantitative calculation for the spatial extent of the return currents of the auroral-zone electrojet shows that they are confined practically to a rather small area in high latitudes and do not extend down to low latitudes, if the electrojet flows in a narrow latitude range within several degrees. Therefore, the low-latitude geomagnetic bays, of several tens of gammas in magnitude, would be attributed partly to some global current circulation in the ionosphere, unless the latitudinal width of the auroral-zone current is greater than 10°. (auth)

12707 WORK AT VOSTOK STATION IN 1966. Artem'ev, A. N. (Vostok Station, Antarctica). Sov. Antarct. Exped. Inform. Bull. (Engl. Transl.); 7: 4-7(Oct 1969).

Geophysical observations made at the Soviet Antarctic station in 1966 which are described included vertical radio soundings of the ionosphere at a frequency of 1 to 10 MHz, the recording of the variations of the neutron component of cosmic rays and the microvariations of the total component of cosmic radiation in the east–west and vertical directions, the recording of the vertical and horizontal components of the geomagnetic field and magnetic declination, visual auroral observations, and auroral photography with a C-180 camera. The joint Soviet–American geophysical program included observations on the forward scattering of vhf in the ionosphere, riometer recording of cosmic radio noise at frequencies of 20.2 and 29.85 MHz, and the recording of geomagnetic micropulsations, Earth currents, very low-frequency emissions, and atmospherics. As in preceding years, geomagnetic disturbances were more intense in summer. The magnetic field was quiet in winter (April–August). Four magnetic storms were recorded throughout the year, the most interesting of which was observed from August 29 to September 6 after a proton flare on the Sun. This storm had two active periods (August 30 and September 3–4) and was accompanied by an interruption in radio communications between Vostok and Mirny and by the absorption of cosmic noise in the ionosphere. Cosmic-ray observations are briefly reported. The flare on the Sun on March 23–25 produced a geomagnetic field disturbance and a sharp drop in the intensity of the neutron component of cosmic rays. Intensity decreased as much as 5.1% on March 23. The decrease in intensity on those days could also be traced in the total ionizing component. The intensity of the neutron component decreased as much as 11.5% during the magnetic storm of August 29–September 6. (BBB)

12708 GEOPHYSICAL INVESTIGATIONS AT MIRNY IN 1966. Smirnov, V. B. (Arctic and Antarctic Scientific Research Inst., Mirny, Antarctica). Sov. Antarct. Exped. Inform. Bull. (Engl. Transl.); 7: 26-7(Oct 1969).

The following observations made at Mirny in 1966 are briefly reported: ionospheric, radio wave absorption in the ionosphere (by the A_1 and A_2 methods), terrestrial magnetism, auroras (optical, visual, radar), measurements of the signal level from radio stations, Earth currents, cosmic rays, and seismology. Along with the regular program, additional observations were organized to acquire a better knowledge of the geophysical phenomena taking place at high latitudes. For observations in radio wave absorption in the ionosphere by the method of extraterrestrial radio emission, absorption measurements were made with an RP-1-40 riometer at a frequency of 40 MHz. The maximum number of occurrences of type-2 anomalous absorption (in the form of individual bays) was recorded in June and July. A total of 44 anomalous absorption bays was observed. The average intensity of the bays was 0.3 to 0.7 dB. Sometimes absorption reached 1 to 2 dB. Absorption bays were usually observed at night with a maximum at midnight local time. Visual auroral observations were made hourly at Mirny. There were 4 maxima in the diurnal pattern of auroral activity: an evening maximum at 19 hr local time, a night maximum at 1 hr, a premorning maximum at 4 hr and a morning maximum at 7 hr. Radar observations of auroras were analyzed to determine the diurnal pattern of reflections and the distribution of reflections according to distances and azimuths. Results are described. (BBB)

12709 EQUIVALENCE IN GROUND GEOMAGNETIC EFFECT OF CHAPMAN–VESTINE'S AND BIRKELAND–ALFVEN'S ELECTRIC CURRENT-SYSTEMS FOR POLAR MAGNETIC STORMS. Fukushima, Naoshi (Tokyo Univ.). Rep. Ionosphere Space Res. Jap.; 23: 219-27(1969).

Two kinds of electric current-systems have been postulated for the world geomagnetic variation during polar magnetic storms; one with field-aligned currents in the magnetosphere (suggested first by Birkeland and later advocated by Alfvén and others), and the other entirely in the ionosphere (depicted first by Chapman and followed by Vestine and others). For a typical minor disturbance in high latitudes, the former may be approximated by a westward electrojet along the auroral zone in the ionosphere with vertical incoming and outflowing currents, while for the latter, a westward auroral-zone electrojet and its return currents in the ionosphere. An intuitive explanation is given in this paper for the equivalence in the ground geomagnetic effect of these two different electric current systems. A difference in the magnetic effect of these two current-systems exists above the ionosphere. For the Birkeland–Alfvén current system, the Hall current of the Chapman–Vestine type is simultaneously produced in the ionosphere. In the stationary state, the contribution to the total electrojet from the Hall current is $(\Sigma_2/\Sigma_1)^2$-times that from the Pedersen current of the Birkeland–Alfvén type, where Σ_2 and Σ_1 are the integrated Hall and Pedersen conductivities of the auroral-zone ionosphere. (auth)

12710 HARMONIC ION-CYCLOTRON RESONANCES OBSERVED BY THE OGO-4 SATELLITE. Kikuchi, H. (Max-Planck-Institut fuer Aeronomie, Lindau, Ger.). Nature (London); 225: 257-8(17 Jan 1970).

It is stated that a new very low-frequency phenomenon associated with the propagation of "whistlers" in the upper ionosphere was found in the vlf recordings from the Injun 3 and Alouette satellites; this showed up on a frequency–time spectrogram as a rising tone that commenced immediately after reception of a short fractional-hop whistler. The spectrogram showed a rapid rise in frequency with an asymptotic approach to the cyclotron frequency for the protons in the plasma surrounding the satellite, and the signals have been called proton whistlers. The present communication is concerned with a new effect associated with these proton whistlers that have been observed in the vlf recordings from the OGO-4 satellite. This new effect appears on a frequency–time spectrogram as several separated, narrow, steady bands of noise, whose center lines are located at multiples of the ion cyclotron frequency. One of the records showing these band-limited noises, together with electron and proton whistlers, is shown. Several features that distinguish these bands from other vlf or elf emissions observed both in the satellite and on the ground are discussed, and it is postulated that the emissions are related to harmonic ion-cyclotron resonances excited in the immediate vicinity of the satellite and that the resonance frequencies depend only on the local value of the Earth's magnetic field at the position of the satellite. Experimental evidence of harmonic ion-cyclotron resonances is sparse and the excitation mechanisms of these resonances are not yet known. It is considered probable that particle beams play a key part in the excitation

of the resonances and that the incoming electron whistler mode provides a triggering effect for this excitation, stimulated also by the nonlinear effects expected in the vicinity of the satellite. With regard to beams of trapped particles in the ambient plasma it is thought that a small number of ions, rather than electrons, of moderate to low velocity are responsible for the excitation of harmonic ion-cyclotron resonances. It is concluded that the observed spectral bands associated with electron and proton whistlers are directly related to the 2nd, 4th, and 6th harmonic ion-cyclotron resonances (the absence of the 3rd and 5th harmonics has not been explained), and that the new phenomenon not only provides an illustration of some basic wave interactions of an ion beam-plasma system, but may also serve as a valuable probe for deeper investigations of the upper ionosphere. (UK)

12711 NEW TYPE OF IONOSPHERIC DISTURBANCE. Rastogi, R. G. (Physical Research Lab., Ahmedabad, India). Nature (London); 225: 258-9(17 Jan 1970).

It is stated that ionograms taken close to the magnetic equator in India have revealed some transient phenomena which appear to be peculiar to the equatorial ionosphere. A new type of vertically moving disturbance is described, which appears to have originated in the E region and moved up through the F_1 and F_2 regions in about 4 hr. The motion of the disturbance was opposite to that observed in the travelling disturbances of higher latitudes; the vertical velocity appeared to be about 16 m/sec, much lower than higher-latitude values. The duration of the uniform upward motion was also much longer than that of traveling ionospheric disturbances. The velocity was of the right order for vertical drift velocity associated with the electrodynamic lift over the equator. (UK)

12712 CHARACTERISTICS OF SMALL DISPERSION WHISTLERS OBSERVED AT MIDDLE LATITUDES. Araki, Takashi; Kamiyama, Hiroshi (Tohoku Univ., Sendai). Rep. Ionosphere Space Res. Jap.; 23: 141-50(1969).

Characteristics of small-dispersion whistlers observed at Tohkatta (140.5° E, 38.1° N, and 27.9° N in geomagnetic latitude) during the period from October 1968 to January 1969 are described. The occurrence of whistlers at Tohkatta shows a diurnal variation similar to that at Toyokawa (137.4° E, 34.8° N, and 24.5° N) during the IGY and IGC. The dispersion changes in a wide range in a course of a day, being extremely small (about 11 $sec^{\frac{1}{2}}$) during the night, and considerably large (more than 30 $sec^{\frac{1}{2}}$) during the daytime. During dawn hours in midwinter, whistlers with duplicate traces were recorded. Both of the traces show almost the same dispersion of about 11 $sec^{\frac{1}{2}}$, and the time interval between them is about 16.5 m sec. Characteristics of these duplicate whistlers present a strong support to the suggestion given by Allcock and McNeill (1966) who proposed the combined propagation of waves in the wave guide mode and in the whistler mode. A quantitative analysis of small-dispersion whistlers observed at Tohkatta leads to the conclusion that waves propagate at first in the wave guide mode from their sources locating near the geomagnetic equator, and then they proceed into the ionosphere in the whistler mode at about 20° in geomagnetic latitude. After reaching the opposite hemisphere, the waves are led to the observing site in the waveguide mode. (auth)

12713 POLAR MAGNETIC DISTURBANCES AND ASSOCIATED INCREASE IN FLUX OF ENERGETIC ELECTRONS IN THE MAGNETOSPHERE. Oguti, Takasi; Kokubun, Susumu (Tokyo Univ.). Rep. Ionosphere Space Res. Jap.; 23: 151-61 (1969).

Change in flux of energetic electrons in the magnetosphere observed by IMP-1 for about two months from March to May 1964 was examined. Statistical distributions of trapped and untrapped energetic electrons during magnetically quiet and disturbed periods in the midnight–dawn sector were obtained. Correspondence between polar magnetic disturbances and abrupt increase in electron flux in the distant magnetosphere was also investigated, and it was found that the time difference between appearance of bay disturbances and flux increase is quite small when the comparison is made along the same geomagnetic line of force. It is concluded that a so-called electron island is not really an island but is an expanding or traveling electron sheet in the magnetotail. (auth)

12714 HYDROMAGNETIC EMISSIONS IN HIGH LATITUDES ASSOCIATED WITH STORM SUDDEN COMMENCEMENTS. II. Oguti, Takasi; Kokubun, Susumu (Tokyo Univ.). Rep. Ionosphere Space Res. Jap.; 23: 162-74(1969).

Hydromagnetic emissions in a frequency range from 0.1 to 1 Hz associated with storm sudden commencements were investigated. The results show that (1) the hydromagnetic emission occurs in association with SSC only at the dayside polar stations, (2) the emission occurs first as a burst at about 80° in geomagnetic latitude on the day side and it extends to the whole day-side polar region within several minutes, and (3) the emissions of band structure with frequency between 0.2 and 0.7 Hz last for several hours following SSC, around the noon high-latitude region. (auth)

12715 ISOTROPIC TURBULENT DIFFUSION FROM SPHERICAL OR CIRCULAR SOURCE WITH NONUNIFORM CONCENTRATION DURING THE INITIAL MOMENT. Panchev, St.; Sirakov, D. God. Sofii. Univ., Fiz. Fak., 61: 177-86(1966-67). (In Russian).

The problem of a spherical source with uniformly distributed concentration at the initial moment inside the sphere was resolved previously from a model of an expanding radioactive cloud during a nuclear explosion in the atmosphere. An attempt is made here at resolving the problem of the same spherical source, considering the effect of nonuniform distribution of concentration at the initial moment on the concentration of admixtures in the subsequent moments. (R.V.J.)

12716 RESULTS OF AN INVESTIGATION OF THE LOCAL AND INTEGRAL ELECTRON CONCENTRATION IN THE IONOSPHERE BY MEANS OF COHERENT RADIO WAVES EMITTED FROM A SATELLITE. I. Al'pert, Ya. L.; Sinel'nikov, V. M. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 331-8(1969).

Translated from Geomagn. Aeron.; 9: 407-17(1969).

The results of experiments from an Elektron satellite with a coherent "Mayak" radio station are reported. The average height dependence of electron concentration in the outer ionosphere and data on integral concentration during the equinoxes of 1964 are obtained. The results obtained agree with those of the Alouette satellite and of other experiments. (auth)

12717 EXCITATION BY WHISTLERS OF LOWER HYBRID RESONANCE IN THE VICINITY OF A BODY MOVING IN A PLASMA. Bud'ko, N. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 350-5(1969).

Translated from Geomagn. Aeron.; 9: 430-6(1969).

The conditions determining the behavior of a field excited by an external current in a plasma after a relatively long period of time in the vicinity of a body moving in the plasma are investigated in the approximation of a cold plasma. The excitation of the lower hybrid resonance upon scattering of a whistler on the trail of a body moving in the ionosphere is discussed. The results obtained are compared with the excitation of the lower hybrid resonance observed on the Alouette satellite. (auth)

12718 ROLE OF THE DYNAMO MECHANISM ASSOCIATED WITH SMALL-SCALE MOVEMENTS OF NEUTRAL PARTICLES IN THE CREATION OF MAGNETIC DISTURBANCES AND IONOSPHERIC INHOMOGENEITIES. Alekseeva, L. M.; Vardanyan, Yu. S.; Tverskoi, B. A. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 356-61(1969).

Translated from Geomagn. Aeron.; 9: 437-44(1969).

The electrodynamic state of the magnetosphere and ionosphere, depending on the character of the small-scale motion of the neutral gas, is investigated. Unlike in the global dynamo theory, allowance is made for the different conditions at conjugate points in the magnetic field. Currents transmitted from the ionosphere to the magnetosphere, the magnetic fields created by them, and disturbances in the density of charged particles in the ionosphere are computed for this case. (auth)

12719 MEASUREMENT OF EFFECTS APPEARING IN THE IONOSPHERE DURING THE PROPAGATION OF RADIO WAVES FROM ARTIFICIAL EARTH SATELLITES. Misyura, V. A.; Solodovnikov, G. K.; Migunov, V. M.; Biryukov, G. A. Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 362-7(1969).

Translated from Geomagn. Aeron.; 9: 445-52(1969).

The method used and the results of an analysis of the difference in the Doppler effect on coherent frequencies and of the Faraday effect of signals from Elektron 1 recorded in February–March 1964 in Khar'kov are described. Data are also presented on the variability of the total electron content and electron concentration in the ionosphere. (auth)

12720 SIMULTANEOUS IONOSPHERIC MEASUREMENTS BY VARIOUS RADIOPHYSICAL METHODS. Misyura, V. A. Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 368-71(1969).

Translated from Geomagn. Aeron.; 9: 453-7(1969).

The results of simultaneous ionospheric investigations at several spaced points by various radiophysical methods are reported. The method used and the results of measurements during the flight of a "vertical space probe" are described. (auth)

12721 CONCENTRATION OF MOLECULAR IONS ACCORDING TO MEASUREMENTS OF THE COSMOS 5 SATELLITE. Dzhordzhio, N. V.; Fedorova, N. I. Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 327-30(1969).

Translated from Geomagn. Aeron.; 9: 402-6(1969).

A method is described for determining the concentration of molecular ions by means of traps on a spinning satellite. The distribution of absolute molecular ion concentrations and temperatures obtained in the height range 200 to 300 km is presented. The dependence of absolute $[NO^+ + O_2^+]$ concentration on the a_p index is found in the range $3 < a_p < 50$. (auth)

12722 STRUCTURE OF PLASMA FLOW IN THE VICINITY OF THE FRONTAL POINT IN THE EARTH'S MAGNETOSPHERE. Samokhin, M. V. (Radio Engineering Inst., Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 318-23(1969).

Translated from Geomagn. Aeron.; 9: 391-7(1969).

The structure of plasma flow in the vicinity of the frontal point inside the magnetosphere is investigated on the basis of a quasi-hydrodynamic model of supersonic flow around the magnetic dipole in the magnetic equatorial plane. The solution is obtained in the form of a power series using as initial data the tangential velocity at the boundary and the shape of the boundary of the forbidden zone in the first approximation of the method of successive approximations for the external flow region. Equipotentials are constructed assuming the longitudinal potential difference to be small compared with the transverse potential difference in the vicinity of the projection of the frontal point of the magnetosphere into the ionosphere and the scales of the corresponding phenomena in the ionosphere are found. (auth)

12723 PENETRATION OF SOLAR PARTICLES TO IONOSPHERIC HEIGHTS AT LOW LATITUDES. Ganguly, S.; Rao, M. (Bose Inst., Calcutta). Nature (London); 225: 169-70(10 Jan 1970).

Since charged particles are guided by the Earth's magnetic field, most of the terrestrial manifestations of solar particles, such as polar cap absorption, auroras, etc., are high-latitude phenomena. Evidence is reported, however, for what is believed to be penetration of solar particles to lower ionospheric heights at a low-latitude station (Calcutta). During continuous measurement of ionospheric absorption over a period of two years, during which period a large number of solar flares was identified by comparing the data with the reported optical flares, in some cases a small but significant increase in absorption for mf radio waves was observed about one hour after the optical flare. The duration of the time lag suggests a particle mechanism. Protons are known to increase the absorption at higher latitudes, and correlation was remarkable between nighttime absorption values and proton counts (E > 60 MeV) from Explorer 33. The small time lag of about an hour suggests a particle energy of the order of 8 MeV, if a linear Sun–Earth trajectory and the emission of protons at the time of the optical flare are assumed. A possibility is that the extra absorption may be due to ionisation by neutrons, which is supported by the detection of neutrons at atmospheric heights in solar particles. It is considered that the possibility of particle ionisation at low latitudes merits closer investigation. (UK)

12724 THE PRE-DAWN ENHANCEMENT OF THE 6300 A [OI] LINE IN THE NIGHTGLOW. Ingham, M. F. (Dept. of Astrophysics, Oxford). Mon. Notic. Roy. Astron. Soc.; 145: 389-400(1969).

Measurements of the emission rate at 6300 Å in the spectrum of the nightglow have been made which show in detail the onset of the pre-dawn enhancement. The results are analyzed to (1) fix the time of onset of the enhancement, (2) determine the form of the curve of emission rate v. time near onset and (3) display short-term variations in the emission rate. (auth) (UK)

12725 VARIATIONS IN THE INTENSITY OF ELECTRONS AND γ-QUANTA IN THE ATMOSPHERE. Bezus, V. A.; Gal'per, A. M.; Dmitrenko, V. V.; (and others) (Moscow Engineering Physics Inst. Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 438-40(1969).

Translated from Geomagn. Aeron.; 9: 540-2(1969).

High-altitude controlled balloons carrying instruments measuring electrons (4 flights) and γ quanta (2 flights) were released in the summer and autumn of 1967. The instrumentation setup is described briefly, and results for the six flights are given. (W.D.M.)

12726 ELECTROMAGNETIC FIELD OF A LOW-FREQUENCY HORIZONTAL ELECTRIC DIPOLE IN THE PRESENCE OF AN ANISOTROPIC PLANE. Davydov, V. M. (Inst. of Geology and Geophysics, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 440-2(1969).

Translated from Geomagn. Aeron.; 9: 543-4(1969).

A thin ionospheric layer is approximated by a double anisotropic plane in order to derive the electromagnetic field of a low-frequency horizontal electric dipole in the presence of the anisotropic plane. (W.D.M.)

12727 FOCUSING OF RADIO WAVES BY AN ARTIFICIALLY CREATED IONOSPHERIC LENS. Bliokh, P. V.; Bryukovetskii, A. S. (Inst. of Radio Physics and Electronics, Kiev). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 443-6(1969).

Translated from Geomagn. Aeron.; 9: 545-8(1969).

Several papers published in recent years examine the influence of high-power radio emission on the ionosphere. The radio beam of a ground transmitter produces in the ionosphere a region with a decreased charged-particle concentration, with a higher index of refraction than the surrounding space. This disturbed region serves as a concentrating lens for radio waves reaching the Earth through the ionosphere. By properly selecting the frequency, power, and radiation pattern of the transmitter, one can focus the ionospheric lens on a given point on the surface of the Earth where the strength of the received signal will be increased. The main parameters of an artificial ionospheric lens are computed on the same basis as Gurevich (1967). (W.D.M.)

12728 DETERMINATION OF THE VERTICAL COMPONENT OF DRIFT VELOCITY AND OF THE RECOMBINATION COEFFICIENT IN THE F REGION OF THE IONOSPHERE. Drobzhev, V. I.; Rudina, M. P.; Solonitsyna, N. F. (Ionospheric Section, Alma-Ata, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 446-7(1969).

Translated from Geomagn. Aeron.; 9: 549-50(1969).

According to Mitra, Rao, and Mahajan (1964) and (1967), for nighttime conditions and with allowance for the vertical component of drift velocity only, the equation of the ionization balance of the F region is reduced to the form $1/N\ \partial N/\partial t = -(\beta t\ \partial v_v/\partial h) - v_v/N\ \partial N/\partial h$, where β is the recombination coefficient, N the electron concentration, and v_v the vertical component of drift velocity. Knowing the vertical ($\partial N/\partial h$) and temporal ($\partial N/\partial t$) gradients of ionization, and also the gradient of vertical drift velocity ($\partial v_v/\partial h$), one can determine β and v_v from the equation. The vertical and temporal ionization gradients were computed on a Minsk-1 computer according to the program of the Alma-Ata station. Of the 160 ionograms analyzed, 47, satisfying the limitations and assumptions of the method, were used. (W.D.M.)

12729 POSITIVE AND NEGATIVE CONJUGATION OF THE IONOSPHERIC F2 LAYER AT LOW LATITUDES. Chin Hong Tjen (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 447-9(1969).

Translated from Geomagn. Aeron.; 9: 551-2(1969).

An attempt was made to determine the presence of a positive and negative correlation of f_0F2 variations at magnetically conjugate stations at low latitudes. The deviation of f_0F2 from median values at seven pairs of conjugate stations from 1958 to 1966 was examined. (W.D.M.)

12730 EXPANSION OF THE DIURNAL f_0F2 PATTERN IN NATURAL UNCORRELATED COMPONENTS. Dvinskikh, N. I.; Naydenova, N. Ya. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 449-51(1969).

Translated from Geomagn. Aeron.; 9: 553-5(1969).

The global distribution of critical F2-layer frequencies is analyzed, using the method of expansion of an empirically given function in natural orthogonal components. This method makes it possible to determine the most characteristic components of the diurnal f_0F2 pattern and to trace the change of their contribution as a function of station coordinates. (W.D.M.)

12731 REFRACTION COEFFICIENT OF AN ANISOTROPIC PLASMA WHEN RADIO WAVE FREQUENCY IS CONFINED BETWEEN GYROFREQUENCIES OF PROTONS AND OXYGEN IONS. Brengauz, V. D.; Brengauz, G. E. Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 452-3(1969).

Translated from Geomagn. Aeron.; 9: 556(1969).

The properties of an anisotropic plasma in the whistler range for $\Omega_H < \omega \ll \omega_H$ and in the case of Alfvén waves for $\omega \ll \Omega_H$ (minimum gyrofrequency of ions in the presence of ions of several kinds in the plasma) have been investigated in detail recently. In this letter, the properties of a plasma in the intermediate case are investigated, with a mixture of ions of various kinds such as protons and oxygen ions being present in the plasma. (W.D.M.)

12732 APPLICABILITY OF A QUASI-STATIONARY APPROXIMATION TO THE SOLUTION OF CHARGED-PARTICLE BALANCE EQUATIONS FOR THE LOWER IONOSPHERE. Krinberg, I. A.; Klimov, N. N.; Velichanskii, B. N. (Inst. of Terres-

trial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 453-5(1969).

Translated from Geomagn. Aeron.; 9: 557-9(1969).

As is known, the solution of charged-particle balance equations is much simplified in the quasi-stationary case when differential equations of balance are replaced by algebraic equations. Therefore, an attempt is made to obtain a criterion of applicability of the quasi-stationary approximation and to estimate the boundaries of the ionospheric region where this approximation is possible. (W.D.M.)

12733 ELECTRIC FIELDS IN THE LOWER IONOSPHERE OVER THE MAGNETIC EQUATOR. Pogrebnoi, V. N.; Fatkullin, M. N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 456-7(1969).

Translated from Geomagn. Aeron.; 9: 560-1(1969).

The results of estimates of electric fields in the lower ionosphere over the magnetic equator, based on rocket investigations of the vertical profiles of the magnetic fields of ionospheric currents under magnetically quiet conditions, are reported. (W.D.M.)

12734 SHORT-PERIOD VARIATIONS OF THE HEIGHTS OF IONOSPHERIC REFLECTIONS. Galkin, A. I.; Erofeev, N. M. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 458-9(1969).

Translated from Geomagn. Aeron.; 9: 562-3(1969).

A device has been developed which makes it possible to obtain data at the output of an AIS ionospheric station in the form of a numerical code on magnetic tape. A series of records of reflections from the ionosphere was made at constant frequency by means of the device and of an AIS station. Using the panoramic display of the AIS, an area was selected for recording where reflections from the layer were sufficiently stable. (W.D.M.)

12735 METHOD OF PARTIAL REFLECTIONS. Vilenskii, I. M.; Plotkin, V. V. (Inst. of Geology and Geophysics, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 459-61(1969).

Translated from Geomagn. Aeron.; 9: 564-5(1969).

It is known from Belrose and Burke (1964) that some information on the parameters of the lower ionosphere can be obtained by means of the method of partial reflections. In this method a strong signal with a carrier frequency of several MHz is emitted into the ionosphere. The signal is reflected in the region above the D layer and, furthermore, it experiences partial reflections from the inhomogeneities of the lower ionosphere. These reflections are received separately and then the ordinary and extraordinary components of scattered signals are compared. This makes it possible to derive definite conclusions on the parameters of the lower ionosphere. (W.D.M.)

12736 ALTITUDINAL ASYMMETRY OF THE INSTANTANEOUS AURORAL ZONE. Khorosheva, O. V.; Emel'yanenko, S. N. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 461-2(1969).

Translated from Geomagn. Aeron.; 9: 566-7(1969).

Various methods of estimating height were applied to the day and night sectors of the instantaneous auroral zone. The method of comparison was used to plot the global picture. (W.D.M.)

12737 INTENSITY DISTRIBUTION IN THE CONTINUOUS AIRGLOW SPECTRUM IN THE RANGE λ 5500 TO 6700 A. Fishkova, L. M. (Abastumani Astrophysical Observatory, Tbilisi, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 463-4(1969).

Translated from Geomagn. Aeron., 9: 568-9(1969).

The intensity distribution in the range λ 5000 to 6700 Å was obtained from spectral observations on an SP-48 spectrograph at Abastumani in a northward direction for a zenith distance of 67°. (W.D.M.)

12738 GEOMAGNETIC PULSATIONS WITH AN INTENSITY MAXIMUM AT MIDDLE LATITUDES. Al'perovich, L. S.; Berdichevskii, M. N.; Van'yan, L. L.; Kocharyants, E. B. (Inst. of Terrestrial Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 467-9(1969).

Translated from Geomagn. Aeron.; 9: 573-4(1969).

In the preliminary results of synchronous observations on geomagnetic pulsations in the USSR in the autumn of 1966, reported by Al'perovich, et al. (1969), it was noted that the amplitude of most pulsations decreases regularly from north to south. The exception to this pattern, observed Sept. 1, 1966, at about 14h UT, is examined. (W.D.M.)

12739 COMPUTATION OF GEOMAGNETIC LINES OF FORCE. Kutimskaya, M. A.; Kuz'min, V. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 469-70 (1969).

Translated from Geomagn. Aeron.; 9: 575(1969).

When solving the equations of continuity for electron and ion concentrations along geomagnetic lines of force, one must know the geometry of these lines. The coefficients of a spherical harmonic analysis of the 1955 epoch were used in the computations. From these coefficients the coefficients of the internal part of the field g_n^m and H_n^m were separated. (W.D.M.)

12740 NONADIABATIC LOSSES OF TRAPPED PROTONS IN THE DIPOLE TRAP OF THE EARTH. Il'in, V. D. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 429-32(1969).

Translated from Geomagn. Aeron.; 9: 530-2(1969).

According to Chirikov (1956) (1959), the motion of a charged particle in a magnetic trap becomes stochastic if the adiabatic parameter ρ_L/R (ρ_L is the Larmor radius and R is the radius of curvature of a magnetic line of force) is greater than some critical value. In this case, variations in the magnetic moment μ of a particle may accumulate upon multiple reflection and this will result in the escape of the particle from the trap. The conditions under which this proton loss mechanism is significant were shown by Il'in (1968). In this note the equilibrium proton fluxes and their outer boundary are determined. (W.D.M.)

12741 RELATIONSHIPS BETWEEN THE PERIOD OF TOROIDAL OSCILLATIONS AND PLASMA CONCENTRATION IN A NONDIPOLE MAGNETOSPHERE. Namgaladze, A. A. (Leningrad State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 432-4(1969).

Translated from Geomagn. Aeron.; 9: 533-5(1969).

An expression N_e/T^2 was obtained which relates the period of oscillations with plasma concentration at the summit of the line of force. The N_e/T^2 values were computed by using a representation of the geomagnetic field in the form of the sum of the dipole field and of the field of surface currents flowing along the magnetosphere boundary. (W.D.M.)

12742 DYNAMICS OF FAST ELECTRON AND ION INHOMOGENEITIES IN THE EARTH'S MAGNETOSPHERE. I. Gurevich, A. V.; Tsedilina, E. E. (Lebedev Inst. of Physics, Moscow. Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 372-9(1969).

Translated from Geomagn. Aeron.; 9: 458-67(1969).

A kinetic equation is obtained that describes the dynamics of an inhomogeneous cloud of fast electrons and ions trapped in the geomagnetic field. It is demonstrated that the motion of fast electrons and ions is accompanied by the appearance of a strong potential electric field. The equations obtained describe this electric field and its action on fast particles and on the ionosphere. (auth)

12743 SOME PATTERNS IN THE VERTICAL DISTRIBUTION OF ELECTRON AND ION CONCENTRATIONS AT HEIGHTS BETWEEN 130 AND 200 km. Shchepkin, L. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 380-4(1969).

Translated from Geomagn. Aeron.; 9: 468-73(1969).

The character of vertical distributions of electron and molecular ion concentrations in the region of the photoionization-rate maximum is analyzed. The height interval 130 to 200 km is considered. (auth)

12744 QUASI-EQUILIBRIUM ION CONCENTRATIONS IN THE IONOSPHERIC E-REGION. Ivanov-Kholodnyi, G. S.; Korsunova, L. P. Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 385-9(1969).

Translated from Geomagn. Aeron.; 9: 474-9(1969).

The main reactions determining ion composition at heights between 100 and 130 km are examined. The results of computations of equilibrium ion concentrations agree fairly well with known experimental facts if allowance is made for the influence of minor neutral components of the atmosphere. It is concluded that the neutral composition in the E layer varies from day to night and in the solar activity cycle. (auth)

12745 METHOD OF MEASURING ABSOLUTE PHASE HEIGHTS IN THE IONOSPHERE. Mirkotan, S. F.; Shibaev, Z. K.; Chan Than Hay (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 390-3(1969).

Translated from Geomagn. Aeron.; 9: 480-4(1969).

Methods of measuring the absolute phase heights of radio-wave

reflection from the ionosphere are described. An analysis is performed in the approximation of geometrical optics for an isotropic medium. (auth)

12746 FREQUENCY DEPENDENCE OF ANOMALOUS COSMIC NOISE ABSORPTION IN THE IONOSPHERE IN THE AURORAL ZONE. Velikovich, V. V.; Benediktov, E. A.; Itkina, M. A.; Petrova, G. A.; Rapoport, Z. Ts. (Gorky State Univ., USSR. Polar Geophysical Inst., Kola, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 394-7(1969).

Translated from Geomagn. Aeron.; 9: 485-90(1969).

The results of observations in 1965 on the level of cosmic noise intensity at frequencies 9, 13, 25, and 40 MHz are used to measure the frequency dependence $\Gamma(f)$ of anomalous radio wave absorption in the auroral zone. The exponents of the frequency dependence are close to n = 2 in 90% of all measurements at 25 and 40 MHz and in 20% of all the frequency pairs. The n values decreased upon transition to lower frequencies in 70% of the cases. In a large number of measurements, the $\Gamma(f)$ dependence was distorted by ionization inhomogeneities. (auth)

12747 MOVEMENT OF AURORAL ABSORPTION ALONG THE AURORAL ZONE. Driatskii, V. M. Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 398-402(1969).

Translated from Geomagn. Aeron.; 9: 491-6(1969).

The movement of auroral absorption is analyzed on the basis of records of galactic radio noise in the auroral zone. It is found that the direction of movement depends on the time of day. Auroral absorption moves from the midnight meridian toward the east and west. (auth)

12748 GEOMAGNETIC STORM FAMILIES IN 1957–1964. I. TWO VELOCITY REGIMES OF SOLAR CORPUSCULAR STREAMS IN DIFFERENT YEARS OF THE SOLAR CYCLE. Afanas'eva, V. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 409-11(1969).

Translated from Geomagn. Aeron.; 9: 505-7(1969).

A catalog of families of geomagnetic storms is compiled for 1957–1964. The velocities of corpuscular streams responsible for geomagnetic disturbances (752 cases) are analyzed on the basis of these data. It is found that when all the data are averaged, the velocity of the streams decreases with solar activity. A detailed examination of the data shows that there are two types of streams in years of decreasing activity: one with velocities characteristic for years of maximum activity and the other with velocities characteristic for years of minimum activity. In 1960 the stream velocities changed (decreased) jumplike. (auth)

12749 RATE OF MAGNETIC FIELD VARIATIONS DURING VERY LARGE MAGNETIC STORMS AT MIDDLE AND LOW LATITUDES. Mikerina, N. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 412-15(1969).

Translated from Geomagn. Aeron.; 9: 508-12(1969).

The characteristics of the rates of magnetic field variations during magnetic storms are described. The rates of variation at equatorial and middle-latitude stations are compared, as well as their longitudinal dependence. The variation during a storm and the geographic distribution of the rates of variation agree well with the behavior of magnetic activity. (auth)

12750 SPECTRAL CHARACTERISTICS OF TYPE Pi2 GEOMAGNETIC FIELD PULSATIONS. Koshelevskii, V. M.; Baranskii, L. N.; Raspopov, O. M.; Troitskaya, V. A.; Schlich, R. (Leningrad State Univ. Univ., Paris). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 416-20(1969).

Translated from Geomagn. Aeron.; 9: 513-19(1969).

The frequency spectra of type Pi2 geomagnetic field pulsations, recorded synchronously at several stations, are constructed. It is shown that the propagation of pulsations from the auroral zone toward middle and low latitudes occurs without significant distortion of the spectral composition of the pulsations. The Pi2 spectra reveal two harmonics that are not multiples of each other. (auth)

12751 PROBABLE GENERATION MECHANISM OF TYPE PPi GEOMAGNETIC PULSATIONS. Chmyrev, V. M. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow. Kalingrad Ionospheric Station, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 421-3(1969).

Translated from Geomagn. Aeron.; 9: 520-3(1969).

The possible interpretation of PPi bursts by the cyclotron instability of proton beams in the magnetosphere is investigated. An expression is found for the growth increment of pulsations and it is shown that the variation of the total amplification factor as a function of frequency agrees well with the experimentally observed distribution of these pulsations by periods. Other PPi characteristics are also described in the framework of the theory proposed. (auth)

12752 EXPERIENCE IN MAGNETIC VARIATION SOUNDING FROM THE INITIAL PHASES OF GEOMAGNETIC STORMS. Rokityanskii, I. I.; Loginov, I. M. (Inst. of Geophysics, Kiev). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 424-7(1969).

Translated from Geomagn. Aeron.; 9: 524-8(1969).

An analysis of the initial phase of geomagnetic storms leads to the conclusion that the Z/H ratio of this phase is very variable and that it is impossible to perform magnetic variation sounding from data at a single point. (auth)

Low-Temperature Physics

Refer also to abstracts 11869 and 13251.

12753 PRECIPITATION PHENOMENA OF Nb–60 Ti–5 Zr SUPERCONDUCTING ALLOY. Kitada, Masahiro; Doi, Toshio (Hitachi Ltd., Tokyo). J. Jap. Inst. Metals; 33: 1115-21(Oct 1969). (In Japanese).

Precipitation phenomena of Nb–60 Ti–5 Zr superconducting alloy, which are related to the critical current density, were investigated by means of transmission electron microscopy. On aging at 350 to 500°C after solution treatment, the Guinier–Preston (G.P.) zone forms at first, and then the intermediate phase appears and changes to α-Ti at a relatively high aging temperature. But the α-Ti could not be observed by aging at temperatures lower than 400°C for about 1000 hr. The size of the G.P. zone ranges from 50 to 200 Å and the zone forms on the $\{112\}$ plane of solid solution. The intermediate precipitate is a hexagonal, the lattice constants of a and c axes of the intermediate precipitate are 2.80 and 9.67 Å, respectively. The size of the intermediate phase ranges between 500 and 3000 Å, and the crystallographic relation with solid solution is $\langle 0001\rangle_{\text{Inter.}} // \{112\}_{\text{bcc}}$. The α-Ti phase is disk-shaped and the habit plane with solid solution is $\{0001\}_{\alpha\text{-Ti}} // \{110\}_{\text{bcc}}$ and $\{112\}_{\text{bcc}}$. On the other hand, the rate of precipitation in the cold-worked specimen is larger than that of the solution-treated one, but the precipitation process is almost similar to that of the solution treated one. The effect of the precipitate on the critical current density becomes more effective in the order of the G.P. zone, the intermediate precipitate and α-Ti. (auth)

12754 CRITICAL CURRENT IN SUPERCONDUCTING FILMS. Shmidt, V. V. (Inst. of Metallurgy, Moscow). Zh. Eksp. Teor. Fiz.; 57: 2095-2106(Dec 1969). (In Russian).

The dependence of the critical current on magnetic field strength in a film of a type-II superconductor is investigated theoretically. The magnetic field is parallel to the film surface and perpendicular to the current. It is assumed that $\delta_0 \gg d \gg \xi(T)$, where δ_0 is the penetration depth of the magnetic field, and d the film thickness. It is shown that in weak fields the critical current is determined by a value for which vortex formation begins at one surface of the film and their movement and destruction at the other end of the film. In fields close to $H_{c1}(d)$, weak currents do not violate the stability of the mixed state; the state is unstable for currents equal to the critical value. From the dependence of the critical current on external magnetic field strength it follows that a peak effect should be observed in strong fields. (auth)

12755 SUPERCONDUCTING PROPERTIES OF PURE NIOBIUM. Karasik, V. R.; Shebalin, I. Yu. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 57: 1973-86(Dec 1969). (In Russian).

The temperature dependence of fields H_{c1}, H_{c2} and H_{c3} is measured by the induction method in niobium samples with a resistance ratio $R(300°K)/R(4.2°K) \sim 10^4$ and 3×10^3. The experimental value of $H_{c2}(0)$ is five times greater than the value calculated from the microscopic theory and the function $H_{c3}(T)$ is found to depend on the purity of the sample. The magnetic properties of niobium in an inclined magnetic field are studied. The applicability of the isotropic model of superconductivity to niobium possessing a complicated Fermi surface is discussed. (auth)

12756 NONLINEAR RESPONSE ABOVE THE SUPERCONDUCTING TRANSITION POINT. I. STATIC FIELD. Tsuzuki, Toshio (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto); 42: 1020-9(Nov 1969).

A general method is given for calculating the nonlinear response to an external disturbance for which complete thermal techniques can be used. Next it is applied to the nonlinear response of electronic current to a static electric field above the transition point. All the dominant contributions from the pair fluctuations are summed up. An approximation method which

is valid near the transition point, and which was applied to several problems of the critical phenomena, is explained in slight detail. (auth)

12757 NONLINEAR RESPONSE ABOVE THE SUPERCONDUCTING TRANSITION POINT. II. ALTERNATING FIELD. Tsuzuki, Toshio (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto); 42: 1030-40(Nov 1969).

The nonlinear response of the excess current due to the pair fluctuation in an alternating and cross electric field is studied, using the thermal techniques of calculation. Discussions are given on the gauge invariance of the current expression. (auth)

12758 NUCLEATION OF THE MIXED STATE IN A NIOBIUM SUPERCONDUCTOR. Letellier, B. P.; Renard, J. C.; Rocher, Y. A. J. Phys. (Paris); 30: 819-22(Oct 1969). (In French).

Nucleation of the mixed state was studied in superconducting niobium samples. Above H_{c1} and below the superheating field H_{SH}, a few vortices are nucleated in the superconductor at an extremely low rate, which increases as the field approaches H_{SH}. Above H_{SH}, the system evolutes towards well-defined metastable magnetic states. Flux penetration appears as a very slow phenomenon controlled by time constants which have been determined. On the contrary, when the applied field is decreased from H_{c2} to H_{c1}, thermodynamically stable states are obtained. (auth)

12759 SUPERCONDUCTIVITY OF Tl-Sn AND Pb-Sn ALLOYS SUBJECTED TO HIGH PRESSURES. Rabin'kin, A. G.; Tonkov, E. Yu. (Inst. of Chemical Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 10: 183-4(5 Oct 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu; 10: 289-91(5 Oct 1969).

T_c and H_{c2} were determined for alloys synthesized at P and T values corresponding on the P-T-C diagrams to new single-phase states with X and X' phases (the initial states are eutectic mixtures: Pb + Sn and γ-Te + Sn). The transition into the superconducting state is plotted for the following samples: an alloy of Sn with 35 at. % Tl in the initial state after annealing for 170 hours at 70 to 80° and an alloy of Sn with 15 at. % Pb in the initial state after annealing for 120 hours at 100° and after synthesis at P = 30 kbar, and T = 280 ± 20°C for one hour. After pressure treatment, T_c increases for the Tl-Sn alloy and decreases for Pb-Sn. (M.H.R.)

12760 DERIVATION OF THE LANDAU QUANTUM HYDRODYNAMICS FOR INTERACTING BOSE SYSTEMS. Bierter, Willy (Univ. of California, Berkeley); Morrison, Harry L. J. Low Temp. Phys.; 1: 65-71(Apr 1969).

It is demonstrated that the basic equations of the Landau hydrodynamics may be derived directly from the quantum-mechanical microscopic N-body Hamiltonian, which is expressed as a functional of the local observables, namely, particle and current densities. The Landau quantum hydrodynamic equations are then the Heisenberg equations of motion of these quantities. (auth)

12761 THE THERMODYNAMICS OF ROTATING LIQUID He II: VORTEX CORE RADIUS. Pollock, F. (Stevens Inst. of Tech., Hoboken, N. J.). J. Low Temp. Phys.; 1: 123-7(Apr 1969).

A thermodynamic treatment of rotating liquid helium is presented, leading to estimates of the vortex core radius. (auth)

12762 FEASIBILITY OF A POWER TRANSFORMER WITH SUPERCONDUCTING WINDINGS. Harrowell, R. V. (Central Electricity Research Lab., Leatherhead, Eng.). Proc. Inst. Elec. Eng. (London); 117: 131-40(Jan 1970).

Although only 0.2% of the total power of a large generator transformer is accounted for by I^2R losses, the capitalized value of this power dissipation is about half the price of an 800-MVA transformer. Superconducting windings with no power losses are therefore a potentially attractive substitute for existing copper windings. However, existing superconductors have ac losses which both reduce the additional capital sum that may be spent and increase the size and cost of the refrigerator. There is virtually no net saving when the cost of additional materials is added to that of the refrigerator. Variations in the size and shape of the superconducting transformer, including an air-cored toroid, probably do not give any worthwhile advantage over a conventional transformer, although, with existing superconductors, the economically most competitive design is significantly larger than its conventional counterpart. It is probable that a straightforward niobium-on-copper winding would not be able to take a short-circuit fault and be immediately ready for normal use. Either a protective system using a switched-in separate copper winding or one using a type 2 superconductor might allow fault conditions to be withstood. No deep study has been made of either the electrical insulation or mechanical loads, both of which will present difficulties. The prospects for a viable superconducting transformer would be much brighter if a low-loss superconductor were developed having running ac losses not much greater than 0.1 W m^{-2} at J_s = 110 Amm^{-1} and, under fault conditions, less than 500 Wm^{-2} at 800 Amm^{-1}. (auth) (UK)

12763 SURFACE RESISTANCE OF SUPERCONDUCTING TIN AT 24 GHz. Zohta, Y. (Electrotechnical Lab., Tokyo). Phys. Lett.; 31A: 21-2(12 Jan 1970).

It is shown theoretically that microwave absorption by interband transitions can arise in multi-band superconductors. Experiments on the surface resistance at 24 GHz show no extra absorption corresponding to the interband transition, but do show deviations from the BCS theory. (auth)

12764 TRANSITION TEMPERATURES OF GRANULAR SUPERCONDUCTORS. Buettner, H.; Gerlach, E. (Battelle Institut e.V., Frankfurt am Main). Phys. Lett.; 31A: 13-14 (12 Jan 1970).

It is shown that Friedel oscillations in granular superconductors give rise to an energy gap at the Fermi surface which reduces the transition temperature. (auth)

12765 MAGNETOHYDRODYNAMIC FLOW WITH SUCTION OR INJECTION AT THE FORWARD STAGNATION POINT. Katagiri, Masakazu (Yamagata Univ., Japan). J. Phys. Soc. Jap.; 27: 1677-85(Dec 1969).

The flow of an electrically conducting and incompressible fluid at the forward stagnation point of an infinite plane wall is studied considering the effect of suction or of injection. On the assumptions of small magnetic Reynolds number and of zero electric field, it is found that the similar solution of boundary layer equations exists when a uniform magnetic field is applied normal to the wall and the velocity of suction or of injection is constant. The similar, solution is expressed in a form of integral equation and obtained by iterative numerical quadratures. Numerical results for various values of parameters are given for the velocity profile, skin friction, displacement thickness and momentum thickness. Further, present numerical results for large suction or large injection are compared with those of asymptotic analyses. It can be concluded that an asymptotic analysis for large suction or large injection might be valid for $K \geq 5$ or $K \leq -3$ and results be in good agreement with those of numerical calculations within a few percent, where K is a parameter of suction or of injection. (auth)

12766 SPECIFIC HEAT AND SUPERCONDUCTIVITY OF La-Ge SYSTEM. Satoh, Takeo (Tohoku Univ., Sendai); Asada, Yuji. J. Phys. Soc. Jap.; 27: 1463-9(Dec 1969).

The low temperature specific heat of orthorhombically distorted C_c-type La-Ge compounds has been measured in order to investigate the origin of an anomalously small specific heat jump, $(\Delta C/\gamma T)_{T=Tc}$, of $LaGe_2$ at the superconducting transition temperature. $LaGe_x$ has an orthorhombically distorted C_c-type crystal structure in the composition range $2.0 \leq x \leq 1.78$. For $2.0 \leq x \leq 1.85$, $(\Delta C/\gamma T)_{T=Tc}$ is anomalously small as in $LaGe_2$. $(\Delta C/\gamma T)_{T=Tc}$ approaches the BCS value at x = 1.78. In the intermediate range, $1.85 < x < 1.78$, there appear two close specific heat jumps as if the samples were of two-phase crystal structure. According to the detailed x-ray study of the crystal structure the curious behavior of $(\Delta C/\gamma T)_{T=Tc}$ seems to be due to some intrinsic origin and a possible model is discussed. (auth)

12767 AN ATTEMPT TO OBSERVE A PHONON DRAG EFFECT BETWEEN PHONONS IN LIQUID HELIUM II AND ELECTRONS IN A METAL SURFACE. Challis, L. J.; Sherlock, R. A. (Univ. of Nottingham, Eng.). Phys. Lett.; 31A: 35-6(12 Jan 1970).

An upper limit to the interaction between phonons in liquid helium and electrons in a metal surface was obtained by an experimental attempt to measure the voltage gradient along the metal produced by a phonon current in the liquid. (auth)

12768 GUIDE TO SUPERCONDUCTIVITY. Fishlock, D. (ed.). London; Macdonald and Company, Ltd. (1969). 150p. 45s.

The present position and the possible future role of superconductors are discussed under the following headings; the origins of superconduction; high-field superconducting materials; the technology of small magnets; the technology of large magnets; superconductors in motion; superconductors and power transmission; superconducting computer devices; and trends in superconductivity. (UK)

12769 LOCAL MAGNETIC FIELD MEASUREMENT IN THE VORTEX STRUCTURE OF A TYPE-II SUPERCONDUCTOR AND COMPARISON WITH THEORETICAL PREDICTIONS. Delrieu,

J.-M. (CEN de Saclay, Gif-sur-Yvette, France). Solid State Commun.; 8: 61-4(Jan 1970).

The nuclear magnetic resonance in niobium in the superconducting state of type II gives the induction B, the maximum field H_m in the vortex, and the magnetic field distribution in the vortex. $\theta = (H_m - H_e)/(H_e - B)$ (H_e is the external magnetic field) near Hc_2 is a constant and the agreement with the theoretical calculation of Eilenberger is good in the impure limit but bad in the pure limit. Therefore, the nonlocal effects, which give $\theta \neq 0$, seem larger than expected. (auth) (UK)

12770 MEASUREMENT OF RESISTIVE TRANSITION TO SUPERCONDUCTIVITY IN THIN ALUMINUM FILMS. Bhatnagar, Anil Kumar; Kahn, Paul; Zammit, Theodore J. (St. John's Univ., Jamaica, N. Y.). Solid State Commun.; 8: 79-82(Jan 1970).

Excess conductivity $\Delta\sigma$ due to superconducting fluctuations has been measured in thin aluminum films above the superconducting transition temperature T_c. Although the theoretical temperature dependence $(T - T_c)^{-1}$ of $\Delta\sigma$ is obeyed by the data, the transition widths are observed to be larger than the Aslamazon–Larkin theory predictions. The ratio between measured and theoretical widths becomes smaller with the increase in resistance per square of the films. (auth) (UK)

12771 GRAIN SIZE AND TRANSITION TEMPERATURE IN QUENCHED ALUMINIUM FILMS. Watton, R. (Royal Radar Establishment, Malvern, Eng.). Solid State Commun.; 8: 105-7 (Jan 1970).

Measurements are reported of corresponding values of resistivity and enhanced superconducting transition temperature in quenched aluminum films. The analysis confirms that the mechanism responsible is that of surface phonons in the grain boundaries. (auth) (UK)

12772 PLASTIC DEFORMATION OF LEAD IN THE NORMAL AND SUPERCONDUCTING STATES. Pustovalov, V. V.; Startsev, V. I.; Fomenko, V. S. (Physical-Technical Inst. of Low Temperatures, Kharkov). Phys. Status Solidi; 37: 413-23(1 Jan 1970).

Results are given of a systematic investigation of the differences between the macroscopic characteristics of plasticity of lead single and polycrystals of 99.9992 and 99.9995% purity in the superconducting and normal states at the same temperature. In the superconducting state, the critical resolved shear stress of single crystals, the yield point of polycrystals, and the flow stress for different stages of deformation are lower than in the normal state. Near the fracture and at the tensile strength, no difference between the flow stress in the normal and superconducting state was observed. A temperature dependence of macroscopic property changes was not found in the temperature range of 1.8 to 4.2°K. The results obtained reveal an essential contribution from the drag due to conduction electrons to the resistance to dislocation motion. The essential interaction with conduction electrons implies that in pure metals the dislocations move with rather large velocities (10^2 to 10^5 cm/sec) at low temperatures. (auth)

12773 EFFECT OF THE SUPERCONDUCTING TRANSITION ON CREEP IN LEAD. Soldatov, V. P.; Startsev, V. I.; Vainblat, T. I. (Physical-Technical Inst. of Low Temperatures, Kharkov). Phys. Status Solidi; 37: 47-51(1 Jan 1970).

The velocity of creep in lead was found to increase sharply at the transition to the superconducting state. The jump of creep rate depends on the sample purity. The magnetic field does not affect the creep curve. Possible causes (change of interaction between electrons and dislocations, change of barriers determining the mobility of dislocations at the superconducting transition) of the observed effect are discussed. (auth)

Plasma and Thermonuclear Physics

Refer also to abstract 13517.

12774 (AEC-tr-7119) MAGNETIC TRAPS, NUMBER 3. Sinel'nikov, K. D. Translation of Magnitnye Lovushki, Vypusk 3, Respublikanskii Mezhvedomstvennyi Sbornik, Kiev, Naukova, Dumka, 1968. 281p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 5378. (M.O.W.)

12775 PLASMA PHYSICS: TECHNOLOGY INDEX. VOLUME 3, NO. 11, 1969. Bibliography, Author Index, Subject Index, Appendix. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1969). 83p.

This listing includes 160 articles on various aspects of plasma physics. (M.O.W.)

12776 PLASMA PHYSICS INDEX. VOLUME 4, No. 11, 1969. Bibliography, Author Index, Subject Index. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1969). 234p.

This listing includes 481 articles on various aspects of plasma physics. (M.O.W.)

Confinement and Heating

Refer also to abstracts 12796 and 12808.

12777 (CTO-672) PLASMA THERMAL ISOLATION AND CONTAINMENT IN THE "SIRIUS" STELLARATOR. Burchenko, P. Ya.; Vasilenko, B. T.; Volkov, E. D.; Rudakov, V. A.; Tolok, V. T. Translated for Culham Lab., Abingdon, Eng., from report FIAN-69-47. 9p. Dep. CFSTI (U. S. Sales Only).

An account is given of the results obtained from investigations of the energy and particle containment in an ohmically heated plasma carried out in "SIRIUS" with the object of throwing some light on the processes mainly responsible for the anomalously high transport coefficients in closed traps. (M.O.W.)

12778 (CTO-674) INFLUENCE OF THE NON-EQUIPOTENTIALITY OF THE MAGNETIC SURFACES ON THE TRANSPORT PROCESSES IN STELLARATORS. Kovrizhnykh, L. M. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of Preprint No. 128. 6p. Dep. CFSTI (U. S. Sales Only).

Expressions are given for the particle fluxes across the magnetic field of an l = n stellarator taking into account the departure between equipotential and magnetic surfaces. The values for the corrections to the potential as a function of the plasma parameters are determined from the quasi-neutrality condition and it is shown that in some cases the noncoincidence between the equipotentials and the magnetic surfaces may be considerable and lead to appreciable changes in the coefficients of diffusion and thermal conductivity. (auth)

12779 (NP-18106) TURBULENT HEATING OF PLASMA IN DISCHARGES WITH SKINNED CURRENT. Dubovoi, L. V.; Fedyakova, V. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Leningrad). 1969. 21p. Dep. CFSTI (U. S. Sales Only).

Results of experimental study of turbulent plasma heating effectiveness in rf discharges with skinned current are reported. On the assumption that in the skin-layer region ion–acoustic instability develops, the calculation scheme of plasma heating effectiveness in such type systems is created, which takes into account the discharge current dissipation in turbulent plasma and transfer phenomena accompanying the energy dissipation of rf fields in a direction perpendicular to the external magnetic field. Applicability of concepts developed in this work to the case of turbulent-plasma heating by single current pulses of short-time duration is discussed. (auth)

12780 NONLINEAR TRANSIENT HEATING OF A WEAKLY IONIZED PLASMA BY AN rf FIELD. El-Khamy, S. E.; McIntosh, R. C.; Tang, T. (Univ. of Massachusetts, Amherst). J. Appl. Phys.; 41: 424-7(Jan 1970).

A study was made of the transient response of the electron temperature to an intense high-frequency step input electric field. Boltzmann solutions are given considering nonlinear effects and electron temperatures. (M.O.W.)

12781 ELECTROSTATIC PLUGGING OF OPEN-ENDED MAGNETIC CONTAINMENT SYSTEMS. Ware, A. A.; Faulkner, J. E. (Aerojet-General Corp., San Ramon, Calif.). Nucl. Fusion; 9: 353-61(Dec 1969).

Results of a theoretical study of the use of electrostatic fields to suppress the plasma losses from magnetic cusps or mirrors are reported. Numerical estimates are given for the maximum plasma densities which can be contained. Assuming stability, the use of electrostatic fields, combined with controlled electron and ion beam injection, makes it possible to generate cusps with a width of 4 ρ_e, where ρ_e is the electron Larmor radius. With such narrow cusps, densities sufficiently high for a fusion reactor can be contained electrostatically. High values of the electric stress tensor ($E^2/8\pi$) are required near the positive electrodes but the magnitude of these values is shown to be appreciably less than the plasma pressure and to be within practical limits. When the electrostatic fields are combined with a nonadiabatic cusp magnetic field, a form of particle beam injection is possible which is orders of magnitude more efficient than existing methods. The main body of the plasma should have a high degree of stability; the only weak regions for stability are in the cusps, where the electrons have been separated from the ions. The conditions in

the cusps are greatly different from any model which has been treated by stability theory; the finite dimensions and nonuniformity in both the longitudinal and transverse directions will have stabilizing effects and the resultant stability of the electron cusps is an open question. (auth)

12782 ACCUMULATION OF PLASMA FOR SEVERAL MILLISECONDS BETWEEN A MIXED-FIELD ACCELERATOR AND A MAGNETIC MIRROR. Geller, Richard; Jacquot, Bernard; Jacquot, Claude (CEN de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. B; 269: 621-4(6 Oct 1969). (In French).

It is shown that the stability of an energetic plasma in the Pléiade machine can be prolonged in the millisecond scale. (tr-auth)

12783 CONTRIBUTION TO THE THEORY OF BEAM HEATING OF A PLASMA IN AN OPEN TRAP. Ryutov, D. D. (Inst. of Nuclear Physics, Novosibirsk, USSR). Nucl. Fusion; 9: 297-306(Dec 1969).

The case where the electron plasma frequency is considerably greater than the electron cyclotron frequency is considered. It is assumed that the electron beam is the source of the electrons which are involved in the acceleration process. It is also assumed that the beam is the source of Langmuir oscillations with an anisotropic spectrum and that the electrons "ejected" from the beam, after interacting with the Langmuir oscillations, diffuse radially and at the same time accelerate. With these assumptions, it is possible to solve the kinetic equation with quasi-linear collision integral and to find the distribution function of the fast electrons at each point in the trap. It is also possible to calculate the "temperature" of the fast electrons and their total energy, and to determine how these quantities depend on the magnetic field strength and on the radius of the diaphragm limiting the diameter of the plasma. The results are in good agreement with experimental data. (auth)

12784 MEASUREMENT OF THE ACCUMULATED DENSITY AND ESTIMATION OF THE LIFETIME OF IONS TRAPPED BETWEEN A MIXED-FIELD ACCELERATOR AND A PERIODIC MAGNETIC MIRROR. Geller, Richard; Jacquot, Bernard; Jacquot, Claude (CEN de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. B; 269: 693-6(13 Oct 1969). (In French).

It is shown that the accumulation and mean lifetime of trapped ions in the Pléiade machine is limited by collisions and not by instabilities. (tr-auth)

12785 NONEXISTENCE OF CLOSED FLUX SURFACES IN A MAGNETIC WELL. Sometani, Taro (Shizuoka Univ., Hamamatsu, Japan); Yamamoto, Kenzo. Jap. J. Appl. Phys.; 9: 137-8(Jan 1970).

It is shown that the existence of closed magnetic or flux surfaces is impossible in a simple magnetic well where the field strength increases outwards in a monotone. If r is taken as a position vector from a certain fixed point in space to a moving point on a magnetic field line, the field strength increases in the direction opposite to r at the point where the magnitude of r is maximum. (auth)

12786 THE EXPERIMENT OF THE PLASMA INJECTION INTO THE HELIOTRON C FIELD. Oshiyama, Hiroshi; Tsuda, Takashi (Kyoto Univ.). Kakuyugo Kenkyu; 24: No. 2, 73-87 (Nov 1969). (In Japanese).

The plasma produced by the linear plasma gun is axially injected into the Heliotron C magnetic field through a small-aperture limiter with 15-mm diameter. The ion temperature is about 20 eV, the electron temperature is about 5 eV, the plasma density range is from 10 to 2×10^{12} particles/cm^3 with mean axial direction velocity 7×10^6 cm/sec. The radial density profile, the transmission factor, the loss from the neutral line and the overall decay time of the plasma density are measured. It is revealed that the Heliotron C field can not cancel out the toroidal drift of the plasma particles in spite of the existence of the θ drift, and the plasma confined in that field escapes out mainly from the neutral line. The decay time due to the neutral line loss is 35 to 80 μsec. (NSA of Japan)

Diagnostics

Refer also to abstracts 12853 and 12855.

12787 (CEA-R-3748) ELECTRON DENSITY AND TEMPERATURE STUDY OF PLASMAS USING A MILLIMETER-WAVE FABRY-PEROT INTERFEROMETER. Bize, Daniel (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov 1969. 172p. (In French). Dep. CFSTI (U. S. Sales Only).

Measurements have been made of the electron density using interferometry in the range from 10^9 to 10^{14} electrons/cm^3, and of the electron temperature by Thomson scattering, of plasmas formed by laser ionization and by high frequency. (auth)

12788 (MATT-610) RATES OF ELECTRON IMPACT TRANSITIONS BETWEEN EXCITED STATES OF HELIUM. Johnson, L. C.; Hinnov, E. (Princeton Univ., N. J. Plasma Physics Lab.). Jul 1969. Contract AT(30-1)-1238. 33p. Dep. CFSTI.

Measurements of electron densities and population densities of excited states of neutral helium are presented for afterglows in the C stellarator. Electron densities range from 10^{11} cm^{-3} to 3×10^{13} cm^{-3} and electron temperatures from 0.04 to 1 eV. Semiempirical cross section formulas for transitions among excited levels are deduced by comparing observed excited-state population densities with solutions of detailed transition rate equations. The agreement between computed and measured values is good when the assumed cross sections are comparable with impact parameter approximation results and poor, especially at low electron densities and temperatures, when classical cross sections are assumed. (auth)

12789 (N-69-35413) NOVEL METHOD FOR DETERMINATION OF ENERGY-LOSS FACTORS FOR SLOW ELECTRONS IN HOT GASES. Interim Report, April 28, 1966-June 30, 1968. (STD Research Corp., Pasadena, Calif.). Aug. 1, 1968. Contract NAS2-3580. 12p. (NASA-CR-73361; STD-68-2). CFSTI.

The energy-loss factor is determined by a new method that employs a high-frequency (2.45 GHz) electric field to elevate the temperature of the electrons above the temperature of the gas and a Langmuir probe to determine the electron temperature. The electron energy-loss factor δ_κ in a given gas κ is then determined by measuring the rate of change of the electron temperature with the high-frequency power used to illuminate the plasma. The determination of δ_κ by this method does not require knowledge of the collision cross sections for momentum transfer or of other transport coefficients or of the number densities of the electrons and neutral particles present. An arc heater was used to generate the hot gas. The energy state of the gas was determined spectroscopically. It is concluded that this is a valid and accurate method for determining energy-loss factors since the experimentally obtained values are in essential agreement with theoretical predictions for various gases over a range of more than two orders of magnitude in the loss factor. (auth) (STAR)

12790 LASER INTERFEROMETRY IN PRESENCE OF TRANSVERSE PLASMA DENSITY GRADIENTS. Medley, S. S. (Univ. of British Columbia, Vancouver). J. Appl. Phys.; 41: 142-50(Jan 1970).

A novel laser interferometric technique involving the use of an unstable external resonator is presented. The unstable resonator greatly facilitates electron density measurements in the presence of plasma density gradients transverse to the direction of beam propagation. The technique is used to obtain time-resolved radial electron density distributions in the implosion stage of a linear z-pinch discharge in argon at filling pressures of 0.1 and 1.0 torr. (auth)

12791 MICROWAVE SCATTERING BY A PLASMA COVERED SPHERE. Twardeck, T. G.; Quinn, Robert G. (Pennsylvania State Univ., University Park). IEEE (Inst. Elec. Electron. Eng.), Trans. Antennas Propagation; AP-17: 823-4(Nov 1969).

Laboratory measurements of the scattering of microwaves by a plasma covered sphere are presented for forward-scattering angles. The radial electron density variation is deduced from these data and a simple model of the experiment. (auth)

12792 A SHORT CYLINDRICAL ANTENNA AS A DIAGNOSTIC PROBE FOR MEASURING COLLISION FREQUENCIES IN A COLLISION-DOMINATED NON-MAXWELLIAN PLASMA. Scott, Larry D.; Rao, Bassur Rama (Harvard Univ., Cambridge, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Antennas Propagation; AP-17: 777-86(Nov 1969).

Investigations have been made to determine the effects of interparticle collisions on the antiresonant impedance characteristics of an electrically short, cylindrical antenna in the vicinity of the plasma frequency of an isotropic non-Maxwellian plasma (a weakly ionized plasma in which the electron–neutral collision frequency for momentum transfer is a function of the electron energy). The dependence of the electron–neutral collision frequency on the electron energy has been taken into account. The experimental results have been compared with the theories proposed by King et al., and Balmain. The use of this antenna as a diagnostic probe for measuring electron–neutral collision frequency and electron density has been investigated. Electron–neutral collision frequencies for helium measured by this technique are in good agreement with theoretical results calculated from the collision cross-section data of Golden and Bandel. (auth)

12793 RADIATION CHARACTERISTICS OF AN ELECTRIC DIPOLE IN A WARM, ANISOTROPIC PLASMA. Chen, Hollis C. (Ohio Univ., Athens). J. Appl. Phys., 40: 4068-73(Sept. 1969).

By means of the dyadic Green's function method, a formula is derived for the impedance matrix of an electric-current source immersed in a warm plasma under the influence of an external static magnetic field. A dispersion equation is given. The results are expressed in terms of the components of the compressivity and the permittivity tensors. It is shown that the power radiated by an electric dipole in such a medium can be written as the Hermitian form associated with the impedance matrix. Some numerical results are also included. (auth)

12794 ION COLLECTION BY A CYLINDRICAL PROBE IN A WEAK MAGNETIC FIELD. Ohguchi, Yasutomo; Miyajima, Shigeki; Yamamoto, Kenzo (Nagoya Univ., Japan). J. Phys. Soc. Jap.; 27: 1617-23(Dec 1969).

The structure of a plasma-sheath transition region surrounding a negatively biased cylindrical probe in a weak axial magnetic field is systematically studied on the basis of the moment equations. A weakly ionized plasma is treated, and it is assumed that the mean free path is long but finite, and that the collision frequency is constant. Since the mean free path becomes short with decrease of the ion current collected, the collision effect plays an important role in the ion collection and the formation of the transition region between plasma and the so-called sheath. The position of the boundary between the transition region and plasma and its dependence on the magnetic field are determined by an effective mean free path. The theory is a generalization of those of Bohm and others, which includes the finiteness of the mean free path and the effect of a weak magnetic field. A reformed Bohm criterion is proposed. (auth)

12795 A METHOD FOR DETERMINING THE PLASMA SPACE POTENTIAL BY AN RF PROBE. Dote, Toshihiko (Inst. of Physical and Chemical Research, Saitama, Japan). J. Phys. Soc. Jap.; 27: 1640-7(Dec 1969).

A method for measuring the space potential of a plasma by means of rf characteristics of Langmuir probe is presented. The principle of the method is based upon a behavior of the rf impedance of the plasma-sheath and -probe system. The sensitivity of the method is expected to be very high, since the rf characteristic at the space potential is remarkable. For example, it was possible to obtain the space potential in order of 2 mV in a mercury diffusion plasma. (auth)

12796 METHODS FOR INVESTIGATING THE CONFINEMENT OF ELECTRONS IN CLOSED SYSTEMS. Peregud, B. P. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz.; 39: 760-4(1969). (In Russian).

The confinement properties of open or closed injection systems are usually studied by means of pulsed injectors located outside of the confining field, determining the lifetime of the electrons on the basis of the decrease of the electron flux. A new method was developed, using direct injection of the electrons by an injector within the system. The electron flux is measured under steady-state conditions at all structural elements, including the injector itself, and at the 4π collector that surrounds the system; at the same time, the volume charge is also determined. The new method makes it possible to examine systems with a complex magnetic field, such as the Tornado, Levitron and Spherators, whereby the vacuum chamber or its liner may serve as collector. The effect of unshielded holders may be eliminated. (TTT)

12797 APPLICATION OF THE HODOGRAPHIC METHOD TO THE STUDY OF NONLINEAR PLASMA PHENOMENA. Sapunkova, O. M. Prikl. Mat. Mekh.; 33: 355-8(Mar-Apr 1969). (In Russian).

In a strong electric field a nonlinear relation prevails between the current density in the plasma and the electric field intensity, rendering the calculation of the vector field difficult. This problem may be resolved by using the electrodynamic equation in the plane of the hodograph where the equation is linear. This approach was applied for the case of a strongly ionized plasma, taking into account the elastic collisions between electrons and ions. Solutions are obtained by separating the variables for a current in an infinite container with nonconducting walls. It is not possible to consider the effect of all of the factors, such as ionization, radiation, inelastic collisions, etc., on the conductivity in strong electric fields; therefore, an approximation method was derived, determining the constant parameters experimentally. A composite boundary problem was derived for solving the electrodynamic equation. (TTT)

Kinetics (General)

Refer also to abstract 11890.

12798 (AEC-tr-7127) DETECTION AND INVESTIGATION OF STIMULATED EMISSION IN ARGON PINCH DISCHARGE. Vasil'eva, A. N.; Zaremba, V. B.; Likhachev, V. M.; Rabinovich, M. S.; Sutovskii, V. M. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of report NP-17892. 38p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 32368. (M.O.W.)

12799 (NP-18102) STUDIES OF THE THRESHOLD OF HIGH-FREQUENCY INSTABILITIES DURING ELECTRON BEAM INTERACTIONS WITH PLASMA. Preprint No. 184. Bogdankevich, L. S.; Raizer, M. D.; Rukhadze, A. A.; Strelkov, P. S. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1969. 30p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The critical plasma density corresponding to the threshold of high-frequency instability in a plasma/beam system was determined. The critical density was studied as a function of electron beam energy, the external magnetic field strength, and geometric dimensions of the system. The threshold conditions for excitation of electrostatic oscillations derived by the dispersion relation for a limited plasma/beam system were in good agreement with experimental data. Correlation of theoretical and experimental data revealed that, in the experimental conditions examined, the critical magnitude of plasma density corresponded to excitation of the axially symmetric type of oscillations. (tr-auth)

12800 ELECTRODYNAMIC PLASMA ACCELERATION. Kolesnikov, P. M.; Stolovich, N. N. (Inst. of Heat and Mass Transfer, Minsk). Inzh.-Fiz. Zh.; 17: 861-5(Nov 1969). (In Russian).

Experimental results on electrodynamic plasma acceleration in coaxial accelerators are presented and compared with theoretical data. The corresponding set of differential equations is solved numerically. It is assumed that in acceleration the mass changes proportionally to the coordinate. (auth)

Kinetics (Experimental)

Refer also to abstracts 12635 and 12788.

12801 (EUR-CEA-FC-472) ENERGY LOSS OF FAST TEST IONS IN A PLASMA. Halverson, Ward (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jul 1968. 15p. Dep. CFSTI (U. S. Sales Only).

Preliminary results of an experiment to measure the energy loss of test ions in a fully ionized plasma are presented. Five to 10-keV protons from the dissociation of energetic H_3^+ ions are captured in a magnetically confined lithium arc plasma (electron density 4×10^{12} cm^{-3}) and lose energy by Coulomb collisions with the plasma electrons. Initial measurements suggest that the proton energy loss may be on the order of 50% less than predictions of the Fokker–Planck equation or the theory of BUTLER and BUCKINGHAM. A spurious signal found during the measurements indicates that the dissociation reaction $H_3^+ \rightarrow 2H^+ + H^-$ has an appreciable cross section for 15- to 30-keV H_3^+ molecular ions in the plasma. (auth)

12802 FREE PLASMA COLUMN IN A HIGH FREQUENCY FIELD AT HIGH PRESSURE. Kapitsa, P. L. (Laboratory of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 57: 1801-66(Dec 1969). (In Russian).

Results of an investigation of plasma in a high-frequency discharge hovering in the middle of a cavity are presented. An arrangement for obtaining a stable discharge is described in which stabilization is attained by rotating the gas. Most of the investigations were performed in deuterium at several atmospheres pressure. For in input power of 20 kW, the discharge length was ~10 cm. Spectra were studied and their theoretical interpretation indicated that the discharge consisted of an inner cylindrical region filled by a hot plasma with an electron temperature of the order of 10^6°K surrounded by a cloud of partially ionized plasma $T = (7 \text{ to } 6) \times 10^3$°K. It is shown that the existence of such high temperatures should be possible because of the temperature discontinuity at the plasma boundary. It is suggested that the discontinuity may be due to the double layer at the boundary. Effective heating of the discharge column by the high-frequency current is due to the anomalous skin effect. Such an interpretation of the plasma processes was confirmed by experiments on the effect of a stationary magnetic field (up to 25 kOe) on the discharge. The ion temperature was studied. Neutron emission observed was not sufficient to permit determinations of the temperature and, in fact, it could not be studied with sufficient reliability in order to establish its thermonuclear nature. Other techniques also do not yield reliable results for determination of the ion temperature. The problem of raising the ion temperature to a degree sufficient

for initiation of a reliable thermonuclear reaction by means of magneto-acoustic oscillations and magnetic thermal insulation is considered. Some preliminary experiments along this line are described. (auth)

12803 OBSERVATION OF ENERGETIC IONS FROM A BEAM-GENERATED PLASMA. Graybill, S. E.; Uglum, J. R. (Ion Physics Corp., Burlington, Mass.). J. Appl. Phys.; 41: 236-40(Jan 1970).

Experiments are described which show that pulsed high-intensity electron beams can accelerate light ions to high energies. A set of time-of-flight measurements shows proton and deuteron energies of 5 MeV, helium ion energies of 9 MeV, and nitrogen ion energies of about 20 MeV, produced by an electron beam with a maximum electron energy of 1.6 MeV. These measurements are confirmed by $^{9}Be(x,n)$ reactions for protons, deuterons, and helium ions. Further confirmation is made with an absorber measurement for the protons. (auth)

12804 EXPERIMENTAL MEASUREMENTS OF THE CHARACTERISTICS OF NORMAL IONIZING SHOCK WAVES. Cross, R. C.; James, B. W.; Watson-Munro, C. N. (Univ. of Sydney). Nucl. Fusion; 9: 329-36(Dec 1969).

A cylindrical shock tube was used to study normal ionizing shock waves propagating, parallel to a steady axial magnetic field, into hydrogen gas at a neutral pressure of 100 mtorr. The shock velocity and post-shock parameters such as magnetic and electric fields, particle density and electron temperature are compared with theoretical calculations of these quantities obtained from the conservation equations and a modified form of the Chapman–Jouguet hypothesis. For the purposes of this calculation it was assumed that the Saha equation was applicable to the plasma. Over a range of steady axial magnetic fields from 0.65 to 12.5 kG and discharge currents from 20 to 160 kA, good agreement was obtained between theory and experiment for shock velocities and for electric fields both behind and ahead of the shock. Density measurements display the predicted theoretical trend, but the measured compression ratios across the shock are low, implying a loss of particles during the ionizing process. (auth)

12805 ON THE BEHAVIOR OF HYDROGEN ISOTOPES IN A dc ARC PLASMA. Vukanovic, D.; Vukanovic, V. (Inst. of Physics, Belgrade). Spectrochim. Acta, Part B; 24: 579-83 (Oct 1969).

The radial distribution of D and H emission in a dc arc plasma burning in D_2O and H_2O vapors was estimated. Enrichment of atomic state deuterium in the plasma compared to the initial mixture was observed. It is shown that this isotopic separation should be distinguished from the demixing effect observed previously on a series of elements in a dc arc plasma. (auth)(UK)

12806 EXPERIMENTS WITH TWO LASER-PRODUCED INTERPENETRATING PLASMAS. Puell, H.; Opower, H.; Neusser, H. J. (Technische Hochschule, Munich). Phys. Lett.; 31A: 4-5 (12 Jan 1979).

The interaction of two high-density interpenetrating LiD plasmas is studied; an energy transfer from the Li ions to the D ions is concluded. (auth)

12807 ENHANCED SCATTERING OF LASER LIGHT FROM A LABORATORY PLASMA. Neufeld, C. R. (Institut fuer Plasmaphysik, Munich). Phys. Lett.; 31A: 19-20(12 Jan 1970).

The profile of laser light scattered from a pulsed arc was measured. The spectrum showed a strong enhancement at the center, but otherwise the results fit well with the predictions for a thermal plasma. The central enhancement is similar to Kegel's computed profile, in which he assumes a small proportion of cold electrons. (auth)

12808 EXPERIMENTAL INVESTIGATION OF ION CYCLOTRON RESONANCE ACCELERATION IN A NONUNIFORM MAGNETIC FIELD. Miyake, Shoji; Sato, Teruyuki; Takayama, Kazuo (Nagoya Univ., Japan). J. Phys. Soc. Jap.; 27: 1611-16(Dec 1969).

Ion acceleration of a plasma in a nonuniform magnetic field by an rf field is investigated. The ions are accelerated along the axis of the magnetic line due to the $\mu\nabla_{\parallel}B$ force, where μ is the magnetic moment of an ion of which energy is increased through cyclotron damping of electrostatic ion cyclotron wave and $\nabla_{\parallel}B$ is the magnetic field gradient along the axis. Ions are accelerated to about 200 eV at rf electric field of 60 V/cm. The computed results of the dispersion relation of the wave, including cyclotron damping, agree well with the experimental ones. (auth)

12809 EXCITATION OF LOW-FREQUENCY OSCILLATIONS AND CONTROL OF TWO-STREAM INSTABILITY SPECTRA. Krivoruchko, S. M.; Kornilov, E. A. (Physical-Technical Inst., Kharkov). JETP Lett. (USSR) (Engl. Transl.); 10: 299-301 (20 Nov 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu; 10: 465-9(20 Nov 1969).

The mechanism of excitation of lf oscillations in two-stream instability, and the possibilities of controlling their spectrum by using hf modulation of the electron beam at several frequencies were investigated. The experimental apparatus and technique are briefly described. (M.O.W.)

12810 PROFILE MEASUREMENTS OF PRESSURE-BROADENED He II LINES. Eberhagen, A.; Wunderlich, R. (Institut fuer Plasmaphysik GmbH, Garching, Ger.). Z. Phys.; 232: 1-10(1970).

Helium plasmas having temperatures of 15 to 23 eV and electron densities of 0.8 to 1.6×10^{17} cm^{-3} were reproducibly established in a 10-kJ theta-pinch experiment. Radial and axial homogeneity of the plasma parameters in the discharge column could be achieved very satisfactorily by superimposing an axial magnetic bias field antiparallel in direction to the main theta-pinch field. This plasma was well suited for Stark profile measurements on the He^{+} lines (4,686, 3,203, 2,733, 2,511 Å) in the visible and near ultraviolet and on the He^{+} lines (1,215, 1,085, 1,025, 992 Å) in the vacuum-uv region. The line profiles recorded are given in the usual $S(\alpha)$ representation and their halfwidth-density dependence is tabulated. Comparison is made with line shapes from other authors where available. (auth)

12811 VACUUM ULTRAVIOLET PLASMA ARC RADIATION SOURCE FOR THE 300 TO 1000 A WAVELENGTH REGION. Levy, M. E.; Huffman, R. E. Contract AF19(628)-5724. Appl. Opt.; 9: 41-7(Jan 1970).

A plasma arc radiation source is described which can produce continuum radiation in the 300 to 1000-Å range from discharges in the gases He, Ne, Ar, Kr, Xe, H_2, and their mixtures. The radiation is emitted from a dc self-stabilized plasma arc column having a core temperature of about 18,000 K. The spectra of major interest are due to ion–electron recombination to the ground state of the neutral atom. These continua extend to wavelengths shorter than the first ionization threshold. For helium, the useful continuum extends from 504 Å to approximately 350 Å. The arc column is observed along its cylindrical axis of symmetry through a small opening in the anode. The radiation source was developed for use in the measurement of cross sections in the vacuum uv using continuously scanning photoelectric spectrometers. The application of the source to measurements in krypton near 500 Å is described. (auth)

12812 EXPERIMENTATION WITH A CROSSED-FIELD PLASMA ACCELERATOR. Michard, J.; de Simone, J. Entropie; No. 29, 42-9(Sep-Oct 1969). (In French).

Preliminary results are presented on a crossed-field plasma accelerator designed at ONERA as element of the driver of a hypersonic wind tunnel. The MHD accelerator has magnesia insulated metal electrodes. Reasonable wear of the walls was obtained during the tests. Comparison of theory and experiment shows good agreement and justifies the use of MHD acceleration as hypersonic tunnel driver. (auth)

12813 HIGH-POWER XENON LASER ACTION IN HIGH-CURRENT PINCHED DISCHARGES. Papayoanou, A.; Gumeiner, I. (Army Electronics Command, Fort Monmouth, N. J.). Appl. Phys. Lett.; 16: 5-8(1 Jan 1970).

Recent experiments using high-current capacitor discharge produced high-power laser action in multiply ionized xenon. Strongest oscillation was found on five simultaneous transitions in the green. These lines had a total peak power of 1.4 kW. In addition, streak camera pictures showed that the onset of laser action begins and is sustained during the interval of time when the plasma is being compressed ("pinched") by its self-electromagnetic forces. (auth)

12814 STUDIES OF AXIAL CURRENT OF CHARGED PARTICLES IN A PENNING SYSTEM WITH ALUMINUM ELECTRODE. Ivanov, S. God. Sofii. Univ., Fiz. Fak., 61: 93-100(1966-67). (In Bulgarian).

Experimental studies of a Penning cathode system revealed a three-component particle beam consisting of positive ions, neutral particles with energy of 1 keV, and electrons with anomalous energy of 20 to 40 eV. An attempt was made to find the source of the anomalous electron energy. Measurements were carried out in gaseous media of 1×10^{-6} to 7×10^{-4} torr, with anode voltage of 1200 V and magnetic field 160 to 500 Oe. It was found that the anomalous-energy electrons form across from the collector cathode or in close proximity to it. (R.V.J.)

Kinetics (Theoretical)

Refer also to abstracts 12865 and 12866.

12815 (AD-695472) NUMERICAL STUDY OF THE EARLY POPULATION DENSITY RELAXATION OF THERMAL HYDROGEN PLASMAS. Final Report, July 1, 1968-March 1, 1969. Limbaugh, C. C.; McGregor, W. K. Jr.; Mason, A. A. (Arnold Engineering Development Center, Arnold Air Force Station, Tenn. ARO, Inc., Arnold Air Force Station, Tenn.). Oct 1969. Contract F40600-69-C-0001. 60p. (AEDC-TR-69-156). CFSTI.

The purpose of this investigation was to examine the early relaxation of the population density distribution of a thermal hydrogen plasma. The system of rate equations describing the transient behavior of all quantum levels was used and solved numerically. Three hypothetical hydrogen plasmas were studied each with an excitation temperature of 10,000°K. Two of the plasmas differed only by the transition probability of the quasi-metastable 2S1/2 eigenstate, whereas the third case used a different initial population density distribution. The plasmas were used to study the fundamental consistency of the mathematical model, the existence and location of the critical level, relaxation to the quasi-steady state, and a quantitative study of the effects of the quasi-metastable level on the excited state population density distribution. The results show that the model is consistent with fundamental theory under strong collision dominance and that the critical level does exist at that level predicted by earlier investigators. (auth) (USGRDR)

12816 (AD-695484) AN APPROXIMATE CALCULATION OF THE DISTRIBUTION OF FLOATING POTENTIAL ON A DIELECTRIC BODY IMMERSED IN A HIGH-DENSITY IONIZED STREAM. Covert, Eugene E.; Ting, Robert Y. (Massachusetts Inst. of Tech., Cambridge. Aerophysics Lab.). Jun 1969. Contract F19628-69-C-0043. 29p. (TR-157; AFCRL-69-379). CFSTI.

The conservation equations for electrons and ions, together with the equation for voltage induced by charge separation are studied for the case of a singly ionized fluid flowing along the dielectric body. Since the electrons are more mobile than the ions, a floating potential is induced on the body to reduce electron flux and increase the ion flux. The net current flux to the wall is thus zero. It is shown that this potential varies along the length of the body because of the change in the charged-particle flux across the fluid mechanical boundary layer. (auth) (USGRDR)

12817 (N-70-11930) COLLISION INTEGRALS FOR NONELASTIC PROCESSES IN PLASMA KINETIC THEORY. Viegas, John R. (National Aeronautics and Space Administration, Moffett Field, Calif. Ames Research Center). Nov 1969. 59p. (NASA-TN-D-5548). CFSTI.

Often in the treatment of plasma dynamic problems the effects of nonelastic encounters must be included. In this note, collision integrals for nonelastic processes that are important in plasma kinetic theory are developed. The following nonelastic interactions associated with the electron Boltzmann equation are presented in detail: inelastic and superelastic encounters between electrons and neutral species, ionization and three-body recombination encounters in which the third body is an electron, and photoionization and two-body recombination encounters. In addition, collision integrals are given for some of the processes that affect the transfer equations of heavy particles (ions and neutrals) and photons. Included here are radiative excitation and deexcitation encounters. The compatibility of these collision integrals with the forms associated with the usual macroscopic rate equations is demonstrated. (auth) (STAR)

12818 (NP-18110) SPECTRA OF MAGNETOHYDRODYNAMIC TURBULENT PLASMA. Preprint No. 160. Livshits, M. A.; Tsytovich, V. N. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1969. 35p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Steady frequency spectra formed during nonlinear interactions of Alfven and magnetohydrodynamic waves were studied. It was observed that scattering on plasma particles was the principal form of the nonlinear interaction. The conditions of stability of the power-law spectrum $W_{\omega 1} = \omega^{-\nu} W_0$ were investigated, and it was found that the power-law spectrum was stable at $\nu \geq 1$. With $\nu = 1$ or 2, the power-law character of the spectra was not disturbed in the process of attaining steady states, in contrast to other values of ν. (tr-auth)

12819 (SC-T-70-4002) PENETRATION OF A NEUTRALIZED ION-ELECTRON BEAM INTO A MAGNETIC BARRIER. CONDITION AFFECTING THE GRADIENT OF THE MAGNETIC FIELD. II. Dolique, J. M. Translated by Marcel I. Weinreich (Sandia Labs., Albuquerque, N. Mex.), from Compt. Rend.; 256: 4170-2(1963). 4p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 17: 28372. (M.O.W.)

12820 THE FOKKER-PLANCK EQUATION USING PROJECTION TECHNIQUES. Muriel, A. (Univ. of the Philippines, Quezon City). Physica; 45: 29-32(17 Nov 1969).

From an exact equation derived from the Liouville equation using projection techniques, three assumptions are used to derive the Fokker-Planck equation, emphasizing the brevity and general usefulness of projective methods. (auth)

12821 CONSTRUCTION OF THE LOCAL FIELD IN THE DIELECTRIC AND PLASMA STATES. Mercier, R. P. (Univ. of Southampton, Eng.). Physica; 45: 95-103(17 Nov 1969).

An analysis was made of the problem of calculating the local electric field and defining the related polarization in a classical assembly of electrons and nuclei, a model which can serve to represent either the dielectric or plasma. In general, the local field acting on an electron is defined as the change produced in the ensemble average field at a point, when it is supposed that an electron is situated there. There is a general expression for the local field in terms of the correlation function of electron and nucleus positions. The relation between the polarizations of the dielectric and plasma states is made clear in terms of this general approach. In a not-too-dense dielectric the usual electric polarization P gives a description of the internal "strain" which leads to the Lorentz local field $4\pi P/3$. In our approach P is replaced by an analogous quantity in terms of which one can express the local field in an arbitrary medium, including the plasma. In the plasma the local field is the damping force in the equation of motion of the mean electron velocity, and this arises from the anisotropic perturbation of the Debye correlation caused by the applied field. (auth)

12822 DISPERSION RELATIONS AND SUM RULES FOR THE TRANSPORT COEFFICIENTS OF DILUTE IONIZED GASES IN A MAGNETIC FIELD. Tip, A. (FOM-Instituut voor Atoomen Molecuulfysica, Amsterdam). Physica; 45: 147-64(17 Nov 1969).

In the presence of a homogeneous magnetic field B the thermal conductivity and shear viscosity tensors of ionized gases are anisotropic. The thermal conductivity tensor contains three independent components, one independent of B, one even and one odd in B. The shear viscosity tensor contains five independent components, one field independent, two even and two odd in B. For pure gases, the transport coefficients which are even in B can be written as the real part of complex functions of the parameter $\zeta = eB/nM$, while the coefficients odd in B are the imaginary parts of these functions. Here e is the charge, M the mass and n the density of the gas under consideration. Using the Chapman-Enskog equations it is then shown that these functions possess an analytic extension in one complex half plane and fall off as $1/|\zeta|$ for large $|\zeta|$; these facts enable one to obtain dispersion relations, connecting the transport coefficients odd in B to those even in B. For mixtures the situation is more complicated. Dispersion relations hold only if all charges have the same sign. However, a number of sum rules hold under more general conditions. (auth)

12823 INTERACTION OF A HIGH-FREQUENCY ELECTROMAGNETIC FIELD WITH A PLASMA IN THE PRESENCE OF A HALL EFFECT. Imshennik, V. S. (Inst. of Applied Mathematics, Moscow); Otroshchenko, I. V.; Ryabenkii, V. S.; Osovets, S. M.; Khodataev, K. V. Nucl. Fusion; 9: 307-17(Dec 1969).

The penetration of a plasma with finite conductivity and Hall constant by the high-frequency electromagnetic field produced by a traveling wave is considered from the theoretical standpoint, with a view to explaining qualitatively the results of experiments on the containment of a hot plasma with the help of a high-frequency field. A nonlinear electrodynamic problem is formulated in the quasi-stationary approximation for a plasma at rest with given constant conductivity and Hall constants—a generalization of the classical skin-effect problem. The problem is solved numerically for the case of cylindrical symmetry and for a wide range of plasma parameters and hf fields. A traveling wave produced by an azimuthal current and propagating over the cylindrical surface in the direction of the system axis is taken as the external source of the hf field. A plasma conductor of fixed radius is located within this surface. On the assumption of sufficiently high plasma conductivity, an effective method of successive approximations is derived; it consists in obtaining alternate numerical solutions of electrodynamic problems that are external and internal to the plasma. The results are used for deriving qualitative and quantitative conclusions regarding the physical characteristics

of the interaction between the plasma and the hf field, and for subsequent comparison of theory with experiment. (auth)

12824 ELECTRICAL CONDUCTIVITY OF PLASMA IN A SPATIALLY INHOMOGENEOUS MAGNETIC FIELD. Hinton, F. L.; Oberman, C. (Princeton Univ., N. J.). Nucl. Fusion; 9: 319-27(Dec 1969).

The electrical conductivity of plasma in a strong spatially inhomogeneous magnetic field has been calculated using the small-gyroradius approximation to the kinetic equation. The current which flows along the magnetic lines is the sum of two parts, one due to the time-independent applied electric field, and the other (secondary currents) associated with gradient-B drifts across the lines. The first part gives the electrical conductivity. It has a non-local dependence on the electric field, when the mean free path is not short compared with the scale length for magnetic variations along the field lines. The kinetic equation is solved by a perturbation technique in the long-mean-free-path limit, and an explicit expression for the conductivity is obtained. The main result is that the inhomogeneity reduces the conductivity approximately by the fraction of trapped particles. (auth)

12825 COLLECTIVE RADIATION FROM PLASMAS. Aono, O. (State Univ. of New York, Buffalo). Nucl. Fusion; 9: 337-41(Dec 1969).

Radiations from plasmas are caused by binary collisions between dressed particles which are not point particles. The impulse approximation leads to the result by Dupree. The dressed particle includes naturally the ion correlation as well as the electron correlation, while the screened particle of Birmingham et al. excludes the former. Any cutoff procedures of divergent integrals are made unnecessary by considering both the remote and close collision. In certain cases the radiation is enhanced by collective interactions. An example is given in which the spectrum is expressed in terms of elementary functions. (auth)

12826 RELAXATION TIMES FOR ESTABLISHING STEADY-STATE POPULATIONS IN OPTICALLY THIN AND THICK PLASMAS. Drawin, H. W. (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). J. Quant. Spectrosc. Radiative Transfer; 10: 33-48(Jan 1970).

Relaxation times τ_1 have been calculated for the ground and the excited states of hydrogen atoms and hydrogen-like ions on the basis of the collisional–radiative model. At low and medium electron densities (non-collisional-dominated plasmas), these times become a sensitive function of the number of reabsorbed photons in the resonance lines and in the resonance continuum. Numerical values of τ_1 for establishing steady-state populations are given for different degrees of reabsorption characterized by effective escape coefficients Λ. (auth)(UK)

12827 EFFECTS OF DUST IN A BOUNDED POSITIVE COLUMN. Breslin, A. C. (University Coll., Dublin); Emeleus, K. G. Phys. Lett.; 31A: 23-4(12 Jan 1970).

Methods are considered for analyzing the complex effects of dust in positive columns, with special reference to plasma parameters, dust temperature, and distribution and movement of the dust; results obtained are in general agreement with experiment. (auth)

12828 ENERGY LOSS BY FAST TEST IONS IN A PLASMA. May, R. M. (Univ. of Sydney). Aust. J. Phys.; 22: 687-99 (Dec 1969).

The energy loss by a fast test ion in a plasma is considered and numerical results are tabulated for the corrections to the usual dominant "ln Λ" term in the loss rate (for all values of the ratio between test ion and plasma thermal speeds). A derivation is presented of the Fokker–Planck equation which treats both close collisions and cooperative plasma effects fully; the resulting equation is not new but the derivation is novel and has simplicities which facilitate calculation. This work is motivated by some recent experiments (which are discussed), but the results are tabulated in such a form as to be generally useful. (Australia)

12829 SOME PARTICLE DISTRIBUTIONS AND PLASMA-MAGNETIC FIELD BOUNDARIES. Walsh, Eleanor W. (Australian National Univ., Canberra). Aust. J. Phys.; 22: 701-14 (Dec 1969).

Three properties of the plasma sheath in quadrupole and hexapole geometries are investigated: the variation of the magnetic field, particle density, and electrostatic potential in the transition layer. Some comparison is made with experimental results. (Australia)

12830 REVISED FORMULATION OF THE KINETIC PLASMA THEORY. Neufeld, Jacob (Oak Ridge National Lab., Tenn.). Int. J. Electron.; 27: 301-17(Oct 1969).

Using the Maxwellian macroscopic approach and analyzing the formulation of the dielectric constant, it is shown that the concept of energy has not been properly incorporated into the current kinetic plasma theory. The difficulties are due to the Boltzmann collisional term $(\partial F/\partial t)_{coll}$ which accounts for a change in the velocity distribution due to collisions alone. If one attempts to rephrase the Boltzmann–Vlasov theory in terms of the Maxwellian macroscopic formulation, one obtains an expression for energy which is not consistent with the meaning of this concept in generalized dynamics. In a revised version developed in this analysis, the Boltzmann collisional term is eliminated and an appropriate collisional operator is introduced which is believed to describe more adequately collisional processes in a plasma. It is assumed that the collisional operator can be applied directly to the electrical intensity of the field interacting with the plasma and is effective in transforming the intensity in a collisionless plasma into a corresponding intensity in a collisional plasma. At the same time the relationship between the electron velocity distribution function and the field intensity is considered to be the same, whether there are collisions or not. In other words, not only a collisionless but also a collisional plasma are assumed to be controlled by a Vlasov-type mechanism which does not take into account explicitly the Boltzmann term $(\partial F/\partial t)_{coll}$. (auth)(UK)

12831 COMMENTS ON THE ELECTRODYNAMICS OF PLASMAS. Hawkins, L. C. (Univ. of Miami, Coral Gables, Fla.). Nucl. Fusion; 9: 363(Dec 1969).

A recent attempt (Karlovitz, B., Nucl Fusion, 8: 319(1968)) to reformulate the electrodynamics of plasma media in terms of the average guiding-center drift current is discussed. The analysis is believed to be in error, and the points in question are discussed. (M.O.W.)

12832 ON THE NATURE OF THE ASYMMETRY OF THE SPECTRAL LINE PROFILES OF HYDROGEN IN A DENSE PLASMA. Sholin, G. V. Opt. Spectrosc. (USSR) (Engl. Transl.); 26: 275-82(Apr 1969).
Translated from Opt. Spektrosk.; 26: 489-505(Apr 1969).

A systematic theory of the asymmetry of the spectral line profiles of hydrogen in a dense plasma is developed on the basis of a quasi-statistical treatment of the ions and an impact treatment of the electrons. It is shown that the main reason for the asymmetry is the inhomogeneity of the electric microfields; the quadropolar interaction plays the dominant role, whereas effects of the next order in the small parameter of the problem, $\lambda = n^2 a_0 R^{-1}$, are the quadratic Stark effect, oscillator strength corrections linear in the electric field of the ions ($E = eR^{-2}$), the change from the frequency scale to the wavelength scale, the multiplier in the expression for the intensity of the components and the octupolar interaction. The quadrupolar interaction corrections are the most significant not only in the formulas for the energy of the Stark components but also in the equations for their intensities. A quantitative interpretation is given for the experimentally observed asymmetries of the Ly-α and Hβ lines, and computed data are tabulated for the asymmetries of other lines of the Lyman, Balmer, and Paschen series. (auth)

12833 TEMPERATURE RENORMALIZATION IN THE NONLINEAR VLASOV PROBLEM. Sadowski, W. L.; Ruthberg, Z. G. (National Bureau of Standards, Washington, D. C.). J. Res. Nat. Bur. Stand.; 73B: 281-91(Oct-Dec 1969).

Ways of improving the representation of the velocity distribution function in the solution of the nonlinear Vlasov equation are discussed. Hermite polynomial coefficients for temperature renormalization are derived. Transformation properties of Hermite polynomials necessary to do this are discussed. Analytic expressions for the truncation error of the temperature renormalized functions are compared with the computer results. (auth)

12834 SELECTIVE EXCITATION OF HARMONICS IN A COLLISIONLESS PLASMA BY TWO COUNTERSTREAMING ELECTRON BEAMS. Sadowski, W. L.; Ruthberg, Z. G. (National Bureau of Standards, Washington, D. C.). J. Res. Nat. Bur. Stand.; 73B: 293-300(Oct-Dec 1969).

The possibility of selective harmonic excitation in a one-dimensional plasma that obeys the Vlasov equation is discussed. Electron beams, collimated in velocity space, are used for this purpose. Conditions on the velocity distribution function to achieve selective excitation are given. The velocity distribution function is expanded in Gram–Charlier series and the expansion coefficients are given. Bounds on truncation errors of the expansion are derived and compared with computer results. (auth)

Production

12835 THE HIGH-FREQUENCY, HIGH-PRESSURE INDUCTIVE DISCHARGE AND THE ELECTRODE-FREE PLASMATRON. Raizer, Yu. P. Usp. Fiz. Nauk; 99: 687-712(Dec 1969). (In Russian).

Although the high-frequency inductive discharges in gases have been known for a long time, they are still not completely understood yet. This phenomenon has been used to obtain high-purity plasma. Confinement of the discharge at high, atmospheric pressures of the gas requires power levels of the order of kilowatts, whereby the plasma temperature may reach about 10,000°K. The heat introduced into the plasma electromagnetically may be removed through the walls, resulting in a steady-state process. The cold gas may be blown through the solenoid and heated in a stationary discharge, leaving the inductor as a dense plasma jet at atmospheric pressure. Such a device is called an inductive plasma torch or plasmatron. The design and construction problems of this system are described, examining discharges in motionless plasma, the metallic cylinder model and the stationary discharge in a flowing gas. (Review article, 60 references). (TTT)

12836 FEATURES OF FORMATION OF INTENSE ELECTRON BEAMS IN A BOUNDED PLASMA. Suladze, K. V.; Tskhadaya, B. A.; Piyutto, A. A. JETP Lett. (USSR) (Engl. Transl.); 10: 180-1(20 Sep 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu; 10: 282-5(20 Sep 1969).

A method is described for producing electron beams with currents of 10^5 to 10^6 A from accelerating voltages of 10^5 to 10^6 V and plasma concentrations of 10^{14} to 10^{15} cm^{-3}. The plasma is passed from a spark source into an accelerating gap, and when the gap current reaches a critical value (2×10^4 A), the electron current is interrupted, with the formation of the electron beam. The potential is concentrated near the cathode, and the plasma breaks up into cathode and anode sections. The beam is strongly focused within the gap. If the gap length is increased to ~10 cm, large losses result. (D.L.C.)

Stability

12837 (AEC-tr-7123) EQUILIBRIUM AND STABILITY OF A CURRENT PLASMA IN TOROIDAL SYSTEMS. Rosinskii, S. E.; Rukhlin, V. G. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of report NP-17973. 25p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 42337. (M.O.W.)

12838 (CTO-671) PLASMA EQUILIBRIUM AND STABILITY IN CLOSED TRAPS WITHOUT ROTATIONAL TRANSFORM. Shafranov, V. D.; Yurchenko, E. I. Translated for Culham Lab., Abingdon, Eng., from Preprint No. 18/1616. 4p. Dep. CFSTI (U. S. Sales Only).

The critical plasma pressure for equilibrium and stability in closed magnetic traps without rotational transform with variable curvature of the axis was estimated. As was shown earlier by Shafranov and by McNamara, the minimum B in such traps can be set up in the presence of fields due to the second and third harmonics, which are periodic over the length of the trap. (M.O.W.)

12839 HYDROMAGNETIC STABILITY OF A PLASMA IN STELLARATORS. Shafranov, V. D.; Yurchenko, E. I. (Inst. of Atomic Energy, Moscow). Nucl. Fusion; 9: 285-9(Dec 1969).

It is shown that, with the help of the sufficient criterion for hydromagnetic stability of a plasma proposed by Solovev, it is possible to calculate for stellarators a nontrivial plasma pressure limit at which there is hydromagnetic plasma stability with respect to arbitrary perturbations. In the simplest case of a two-turn stellarator with a circular magnetic axis, this limit has the form $\beta \leq (\delta U_0/U_\phi)(\iota/2\pi)^2$. (auth)

12840 STABILITY OF A MONOCHROMATIC WAVE IN A PLASMA. Shapiro, V. D.; Shevchenko, V. I. (Kharkov State Univ.). Zh. Eksp. Teor. Fiz.; 57: 2066-78(Dec 1969). (In Russian).

It is shown that the equilibrium state corresponding to propagation of a monochromatic wave in a plasma is unstable. Two instability mechanisms are investigated. In one case, instability is due to stimulated scattering of waves by thermal plasma particles and, in another, the instability occurs on particles captured in a potential well created by the wave. The captured-particle instability results in excitation in the spectrum of satellite oscillations whose frequencies are shifted with respect to the main wave by a quantity $\sim k_0\sqrt{e\varphi_0/m}$, where k_0 is the wave number and φ_0 the potential amplitude of the wave. (auth)

12841 ION CYCLOTRON INSTABILITY OF MIRROR-CONFINED PLASMAS. Hamasaki, S.; Chu, M.; Forsen, H. K. (Univ. of Wisconsin, Madison). J. Phys. Soc. Jap.; 27: 1631-4(Dec 1969).

The ion cyclotron instability of a mirror-confined plasma is analyzed based on the power consumption of the internally created electrostatic field in the plasma itself. The relative importance of two kinds of ion cyclotron modes, "anisotropy" and "loss-cone," depends on the plasma density through the instability frequency band width as well as the temperature ratio of the parallel and perpendicular components. The amount of cold ions necessary to quench these instabilities is calculated for plasmas of various densities. (auth)

12842 LOW-FREQUENCY PLASMA STABILIZATION BY FEEDBACK-CONTROLLED NEUTRAL BEAMS. Chen, F. F.; Furth, H. P. (Princeton Univ., N. J.). Nucl. Fusion; 9: 364-6 (Dec 1969).

The stabilization of the resistive drift waves by neutral beam injection is discussed. Some numerical examples are described. (M.O.W.)

12843 PLASMA EQUILIBRIA IN THE POLOIDAL HELIOTRON FIELD. Oshiyama, Hiroshi (Kyoto Univ.). Kakuyugo Kenkyu; 24: No. 2, 65-72(Nov 1969). (In Japanese).

The equilibrium of plasma in the poloidal Heliotron field and its stability are studied in the limit of MHD approximation. The distribution of plasma pressure with maximum value on the separatrix satisfies both the equilibrium and the stability conditions against flute-type instability. (NSA of Japan)

Thermonuclear Processes

Refer also to abstracts 11867 and 12891.

12844 (AD-695456) SPACE TIME, AND ENERGY DISTRIBUTION OF NEUTRONS AND X RAYS FROM A FOCUSED PLASMA DISCHARGE. Report for July 1967-February 1969. Bernstein, Melvin J.; Meskan, David A.; van Paassen, Hugo L. (Aerospace Corp., El Segundo, Calif.). 4 Sep 1969. Contract F04701-69-C-0066. 37p. (TR-66(5220-50)-4; SAMSO-TR-69-304). CFSTI.

The energy spectrum and spatial distribution of neutrons emitted by a plasma focus device were measured with nuclear emulsions and scintillation detectors, and the results are reported. X-ray intensity measurements were made for x-ray energies of $7 < E_p < 30$ keV and showed an $1/E_p^2$ dependence, which does not agree with plasma bremsstrahlung, but appears to result from anode bombardment of axially accelerated electrons with energies >200 keV. The line radiation corresponded to that of fairly cold ions. (auth) (USGRDR)

12845 (KFK-992) CALCULATION OF THE NEUTRON EMISSION OF A D-T PLASMA PRODUCED WITH A CAVITY-PINCH DISCHARGE. Frank, R. G. A. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Kernverfahrenstechnik). June 1969. 47p. (In German). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Technische Hochschule, Karlsruhe, Ger.

A differential equation system was formulated to describe the electron and ion temperatures of a plasma layer. By addition of a pressure term in the motion equation, the collapse of the plasma cavity cylinder to a cylinder was significantly affected. This pressure term means, without additional assumptions, that the external dimensions in the compression of the plasma column is negligibly small. The plasma temperatures were determined in the starting phase after the ignition of the discharge primarily by ohmic heating of the electrons and during the collapse by the adiabatic compression of the plasma. Considering ohmic heating and the varying layer thickness, the cavity pinch process in a wide range was independent of the initial temperature and the initial layer density. The calculation of the neutron number emitted by the plasma was then possible. The conditions for maximum neutron production are given. The effects of the variation of the initial radius at different capacities, variation of the height of the cavity cylinder, variation of the supply voltage, and variation of the initial wall intensity on the optimization of the neutron yield were studied. Processes at the beginning of the discharge were qualitatively analyzed. (J.S.R.)

12846 (LA-4142) PROBLEMS IN THE DESIGN AND MANUFACTURE OF ENERGY STORAGE CAPACITORS. Boicourt, Grenfell P. (Los Alamos Scientific Lab., N. Mex.). Jun 1968. Contract W-7405-eng-36. 14p. Dep. CFSTI.

During the past few years much developmental work has been

done to provide better energy storage capacitors for controlled thermonuclear research. One of the most serious problems in the manufacture of energy storage capacitors is a lack of understanding of the type of faults which can arise during fabrication. This report gives a detailed description of the types of faults found in various energy storage capacitors and discusses their origin, including variations in margins and active widths introduced by the winding machines. Formulas for estimating margin fields and pad overvoltages are derived. (auth)

12847 (MATT-726) DIGITAL CONTROL OF A RESEARCH DEVICE. Simon, Ellis D.; Duritt, Steven P.; Pelovitz, M. (Princeton Univ., N. J. Plasma Physics Lab.). Dec 1969. Contract AT(30-1)-1238. 11p. (CONF-690452-1). Dep. CFSTI.

From Symposium on Engineering Thermonuclear Research, Los Alamos, N. Mex.

Operation of the FM-1 research device at the Plasma Physics Laboratory will require an entirely new control complex. This system will provide the functions of startup, shutdown, enable-disable and start-stop. In providing these functions the control system must be designed in such a way that failure will not cause a hazard to personnel or equipment. In operation, the FM-1 operator will use lighted push buttons in the console. Conditions that prevent the normal sequence of operation will be displayed on a storage scope. Field levels and timer settings can be set by a 10-button "touch tone" input. The normal operations log will be printed on the typewriter. Parameter settings will be punched on cards. (auth)

12848 (ORNL-TM-2821) CONCEPTUAL DESIGN OF ORMAK FACILITY. Kelley, G. G.; Roberts, M.; Clarke, J. F. (Oak Ridge National Lab., Tenn.). Dec 1969. Contract W-7405-eng-26. 24p. (CONF-690931-3). Dep. CFSTI.

From International Symposium on Closed Confinement Systems, Dubna, USSR.

The ORMAK facility is designed to make available a TOKAMAK-like plasma for basic studies leading toward an evaluation of the TOKAMAK approach to controlled thermonuclear fusion. Azimuthal symmetry and diagnostic access are achieved by producing the toroidal magnetic field (B_0) with a single-turn coil uniformly fed from a toroidal transformer. Probable asymmetries in the poloidal and vertical magnetic field structures are avoided by taking special precautions in locating the current-carrying conductors. Through the use of high current joints it is possible, by changing the B_0 coil, to change the aspect ratio ($A \equiv R_{major}/r_{minor}$) or even the shape of the chamber. The aspect ratio A can be as low as 2 with $B_0 = 50$ kG, $R_{major} = 40$ cm and an experimental time at least equal to an energy replacement time. (auth)

12849 NUCLEAR FUSION REACTIONS PRODUCED BY A LASER BEAM. Floux, Francis; Cognard, Daniel; Bobin, Jean-Louis; Delobeau, Francis; Fauquignon, Claude (CEA, Villeneuve-Saint-Georges, France). Compt. Rend., Ser. B; 269: 697-700 (13 Oct 1969). (In French).

In focusing a triggered laser beam on a solid deuterium target, a neutron emission arising from the plasma discharge was observed. The electron temperature was measured, and control experiments were carried out, determining precisely the origin and nature of the detected neutrons. (tr-auth)

12850 A SIMPLE VACUUM CROWBARING SWITCH UP TO 1 MA. Akiyama, Ryuichi; Kawasaki, Sunao; Uchida, Taijiro (Nagoya Univ., Japan). Jap. J. Appl. Phys.; 9: 150(Jan 1970).

A simple low-inductance vacuum switch was designed to apply in a θ-pinch system of the BSG experiment in the Institute of Plasma Physics. The current fed from a condenser bank of 210 μF energized to 20 kV is led to a single turn-coil and is crowbarred after the first quarter cycle. The parameters of the θ-pinch system are shown. (auth)

12851 WELL DEPTH, ROTATIONAL TRANSFORM, AND SHEAR OF TOKAMAK-LIKE CONFIGURATIONS. Takeda, Tatsuoki; Tanaka, Masatoshi (Japan Atomic Energy Research Inst., Tokai). Kakuyugo Kenkyu; 24: No. 2, 88-99(Nov 1969). (In Japanese).

Magnetic well, rotational transform, and global shear are calculated analytically for a simple class of axially symmetric toroidal plasma equilibria. It is shown that a deep magnetic well and a large magnetic shear are realized for toroidal configurations with a small aspect ratio. (NSA of Japan)

12852 ION SOURCE. Tawara, Hiroyuki (to Hitachi Ltd.). Japanese Patent 1969-23679. 6 Oct 1969. Filed 21 Jun 1965.

The ion source proposed, used for nuclear fusion research for example, has the advantage of being able to align the intermediate electrode and the anode and to adjust the distance between the two electrodes, without breaking the vacuum. The overall construction of the ion source is as follows: a filament; the intermediate electrode in the form of a flanged compartment, surrounding the filament with a plasma exit; the anode with a hole corresponding to the opening in the intermediate electrode; and an electrode to extract the ion beam. A bellows, made of metal, supports the intermediate electrode on the anode. Means are provided for moving the intermediate electrode relative to the anode, so that the opening and the hole may be aligned and the distance may be adjusted. An iron core is set between the intermediate electrode and its flange to compensate for the magnetic reluctance between the flange and the anode. (NSA of Japan)

Wave Phenomena

Refer also to abstract 12840.

12853 (AD-481429) PLASMA OSCILLATIONS IN LOW-PRESSURE GASEOUS DISCHARGES. Ketchel, Robert J.; Zobel, William M. (Naval Postgraduate School, Monterey, Calif.). 1963. 115p. CFSTI.

Thesis.

Druyvesteyn analysis (using electronic methods for obtaining first and second derivatives of probe current versus probe potential) and Langmuir probe techniques, are utilized for the investigation of discharges in neon, argon, and krypton at ten microns pressure. Plasma densities as determined from the positive ion section of the probe current curves, from Druyvesteyn analysis, and from observed electron oscillation frequencies, are compared with oscillation amplitudes. Electron oscillations were not detected throughout the discharge; however, at some positions, multiple frequencies were detected. Ion oscillations, detected throughout the discharge, corresponded in magnitude to Langmuir electrostatic sound waves, and peaked in amplitude with the electron oscillations. (auth)(USGRDR)

12854 (AD-695798) TRANSIENT SIGNAL PROPAGATION IN ANISOTROPIC PLASMAS. Case, Carl T.; Haskell, Richard E. (Air Force Avionics Lab., Wright-Patterson AFB, Ohio). Aug 1969. 29p. (AFAL-TR-69-137). CFSTI.

The long time transient response of a lossless, anisotropic plasma to a short electromagnetic pulse is given. The solution is obtained using the asymptotic saddle-point method and is restricted to the cases of propagation parallel to and those perpendicular to the static magnetic field. The results indicate that natural oscillations occur and that these oscillations asymptotically approach the plasma cutoff and resonance frequencies for long times. In addition, complicated transient polarization effects are present in the response signal. (auth) (USGRDR)

12855 (AEC-tr-7129) INTRODUCTION TO THE STATISTICAL THEORY OF NONLINEAR PARTICLE-WAVE INTERACTION IN A PLASMA. Kovrizhnykh, L. M. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of reports NP-17885 (Pt.1); NP-17885(Pt.2). 103p. Dep. CFSTI.

A general theory of the statistical interaction of charged particles and waves in a plasma and a derivation of the basic equations for the weakly turbulent plasma are given. The application of these equations to concrete problems of the physics of a weakly turbulent plasma is discussed. The interaction of radiation with a turbulent plasma and the solution of the nonlinear problem instability of a nonisothermal plasma are described. (M.O.W.)

12856 (ITF-69-68) TO THE ECHO THEORY IN PLASMA. Sitenko, A. G.; Nguyen Van Trong; Pavlenko, V. N. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 19p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Echo effects in plasma are considered, conditioned by the undamped character of the distribution function vibrations, originating under the influence of perturbations, shifted in time. A case of two exterior perturbations is considered. The high- and low-frequency echo vibrations, originating in plasma under the influence of exterior charges were investigated, particular consideration being given the echo effects related to the vibration transformation. It is shown that in plasma there are possible echo phenomena related to the vibrations, whose dispersion is determined by the character of the distribution function exterior perturbations. The echo vibrations in nonequilibrium plasma are considered in which there is the directed motion of particles. It is shown that repeated excitation in plasma of the highly damping short-wave vibrations can be accompanied by the emergence of the long-wave echo vibrations, resulting in instability. (auth)

12857 (ITF-69-73) TO THE ECHO THEORY IN PLASMA OF THE THREE-MOMENTA ECHO VIBRATIONS. Sitenko, A. G.; Nguyen Van Trong; Pavlenko, V. N. (Akademiya Nauk Ukrainskoi

SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 15p. (In Russian). Dep. CFSTI (U. S. Sales Only).

A consideration is made of the echo vibrations in plasma arising due to superposition of three successive perturbations divided in time by the intervals, large as compared with the characteristic time of damping of the vibrations. Perturbations are chosen in the form of plane waves with the wave vectors of perturbations being assumed colinear one to another, therefore echo vibrations of the second order are impossible. The possibility of echo vibrations of the third order is shown, if the wave vectors of perturbations lie in one plane. The origin time and the form of echo vibrations of the second order are found. It is shown that, even in the case of longitudinal perturbations, the field of echo vibrations involves both the longitudinal and cross components. A number of examples of the origination of echo vibrations of the third order are considered. (auth)

12858 (N-69-40811) PROPAGATION IN A PLANAR INHOMOGENEOUS PLASMA MEDIUM. Norgard, John D. (Jet Propulsion Lab., Pasadena, Calif.). 1 Nov 1969. Contract NAS7-100. 38p. (NASA-CR-106397; JPL-TR-32-1394). CFSTI.

The theory of wave reflection and refraction in a planar inhomogeneous plasma medium is presented. The first method for determining the reflection and refraction coefficients for various inhomogeneous distributions is to stratify the medium into thin plasma layers, each containing a homogeneous plasma, and satisfy the boundary conditions on the field vectors across each layer. The second method is to examine the change in the reflection and refraction coefficients as the medium is constructed from one edge to the other by the addition of planar layers of infinitesimal thickness. The reflection and refraction coefficients satisfy Riccati equations, which are solved numerically to yield the desired coefficients. (auth) (STAR)

12859 (N-70-11953) CASCADE MECHANISM OF NONLINEAR INTERACTIONS BETWEEN MODES IN A TURBULENT PLASMA. Tchen, C. M. (City Coll., New York). Oct 1969. 15p. (NASA-CR-106909). CFSTI.

A cascade concept is utilized for the problem of closure, which is characteristic of any nonlinear system. The spectra of kinetic and electrostatic energies are investigated for both the collisional and collisionless cases. The anomalous diffusion, called Bohm diffusion, is also derived and found to play an important role in the nonlinear transport properties of the energy flux across a potential spectrum. (auth) (STAR)

12860 REFLECTION AND TRANSMISSION OF ELECTROMAGNETIC WAVES NORMALLY INCIDENT ON A PLASMA SLAB MOVING UNIFORMLY ALONG A MAGNETOSTATIC FIELD. Chawla, Basant R.; Unz, Hillel (Univ. of Kansas, Lawrence). IEEE (Inst. Elec. Electron. Eng.), Trans. Antennas Propagation; AP-17: 771-7(Nov 1969).

Power reflection and transmission coefficients are found for linearly and circularly polarized plane electromagnetic waves, normally incident on a plasma slab, moving uniformly along a magnetostatic field, normal to the slab boundaries. The solution is found by applying the boundary conditions in the rest frame, and then using relativistic transformations for the fields and the plasma parameters to find the reflection and transmission coefficients observed in the laboratory frame. The results for the circularly polarized incident waves are found in closed form. Numerical results are presented for linearly polarized incident waves. It is found that with an increase in the magnetostatic field, the absolute maximum of the reflection coefficient increases at different velocities. An increase in the magnetostatic field makes the slab more transparent at velocities for which the transmission coefficient with no magnetostatic field is very small. A dielectric-like behavior is observed for large magnetostatic fields. The sum of the power reflection and power transmission coefficients is found to be no longer equal to unity for velocity different from zero. (auth)

12861 WAVE PROPAGATION IN RELATIVISTICALLY MOVING WARM MAGNETOPLASMA. Chawla, B. R. (Bell Telephone Labs., Inc., Murray Hill, N. J.); Unz, H. IEEE (Inst. Elec. Electron. Eng.), Trans. Antennas Propagation; AP-17: 822-3 (Nov 1969).

The refractive index equation for electromagnetic waves propagating in a relativistically drifting warm magnetoplasma is derived by applying Lorentz and plasma parameters transformations to the refractive index equation in the rest system. Two cases are considered: 1) the nondrifting boundary and 2) the drifting boundary. (auth)

12862 QUASI-LINEAR THEORY OF ION OSCILLATIONS IN A MAXWELLIAN PLASMA. Braun, Jean-Claude (Laboratoire de Physique des Milieux Ionises, Nancy). Compt. Rend., Ser. B; 269: 625-8(6 Oct 1969). (In French).

Results are given from a general theory of second order for oscillations of a Maxwellian plasma in which the electron and ion distribution functions are solutions of the corresponding Vlasov equations. This theory is then applied to ion oscillations. (tr-auth)

12863 THEORY OF FLUCTUATIONS IN A NONEQUILIBRIUM ELECTRON GAS. II. SPATIALLY INHOMOGENEOUS FLUCTUATIONS. Shulman, A. Ya.; Kogan, Sh. M. (Inst. of Radio Physics and Electronics, Moscow). Zh. Eksp. Teor. Fiz.; 57: 2112-19(Dec 1969). (In Russian).

The correlation functions of spatially inhomogeneous fluctuations in an electron gas in a strong electric field are calculated for small inelasticity of the collisions. Two limiting cases are considered, when (1) the interelectron collision frequency is zero, and (2) interelectron collisions are predominant. The differential conductivity $\sigma_{\alpha\beta}(k,\omega)$ and spectral density of extraneous current fluctuations are found in the first case. In the second case, the electron temperature approximation is employed and the long-wave and low-frequency fluctuations of the electron concentration and temperature are determined. Transport equations for the fluctuations are obtained, and the correlation functions of the corresponding Langevin functions are calculated. (auth)

12864 SELF-CONSISTENT PROPAGATION OF AN ELECTROMAGNETIC WAVE AND POWER ABSORPTION AT THE ELECTRON GYRORESONANCE IN A PLASMA IMMERSED IN A NON-UNIFORM MAGNETIC FIELD. Brambilla, M. (CEN de Saclay, Gif-sur-Yvette, France). Nucl. Fusion; 9: 343-51 (Dec 1969).

The self-consistent equation for the propagation of a right-hand polarized electromagnetic wave in a cold plasma immersed in a nonuniform magnetic field is solved exactly under the assumption that the parallel electron velocity $v_{||}$ is constant. This equation, which properly takes into account the dissipative component of the induced current, leads to expressions for the reflection, transmission and absorption coefficients which reduce to those obtained by Stix and Budden in the limit $v_{||} = 0$. The reflection coefficient is found to vanish identically, while the absorption is almost complete if the density is sufficiently high. An approximate solution is then obtained for the case where the nonlinear effects in the resonance zone (axial acceleration, relativistic change of mass) cannot be neglected. It is found that these effects can give rise to substantial wave reflection. Thus, at high hf power, the electromagnetic energy is effectively coupled to the plasma only if the density is high enough to reduce the intensity of the electric field in the resonance region to a level such that the linear theory applies. (auth)

12865 ASYMPTOTIC METHOD FOR THE VLASOV EQUATION. II. Taniuti, Tosiya (Nagoya Univ., Japan). J. Phys. Soc. Jap.; 27: 1634-9(Dec 1969).

An asymptotic method for the Vlasov equation developed in a previous paper is reformulated in the Eulerian representation. Then the theory is compared with that of Al'tshul' and Karpman; differences between these theories are emphasized. (auth)

12866 ASYMPTOTIC METHOD FOR THE VLASOV EQUATION. Imamura, Tsutomu (Kaansei Gakuin Univ., Nishinomiya, Japan); Sugihara, Ryo; Taniuti, Tosiya. J. Phys. Soc. Jap.; 27: 1623-30(Dec 1969).

The long-time asymptotic behavior of a weakly Landau-damped, monochromatic plasma wave in a collisionless electron plasma, the amplitude of which is assumed small but finite, is studied. The theory is based on an asymptotic expansion in terms of the decay constant of the Landau damping. The method of characteristics to integrate the Vlasov equation is brought into the scope of the asymptotic method. It is then shown that the slowly varying part of the amplitude Landau damps if the decay time is much shorter than the period of the amplitude oscillation, while it oscillates if they become of the same order. (auth)

12867 DESCRIPTION OF WAVES IN A NONUNIFORM MAGNETIZED PLASMA TO ALL ORDERS IN ELECTRON AND ION TEMPERATURE. Monfort, J.-L.; Vandenplas, P. E. (Ecole Royale Militaire, Brussels). Phys. Lett.; 31A: 11-12(12 Jan 1970).

A general description of waves (including the differential equation for the electromagnetic field) in a nonuniform magnetized plasma is given to all orders in the electron and ion temperature and permits the complete treatment of a bounded plasma. (auth)

12868 COMMENTS ON MICROWAVE SCATTERING FROM ANISOTROPIC PLASMA TURBULENCE. Bugnolo, Dimitri S. Appl. Phys. Lett.; 16: 66-7(15 Jan 1970).

Some comments are directed towards a recent paper (Granatstein, Appl. Phys. Lett., 13: 37(1968)) on the subject of microwave scattering by a well-underdense anisotropic weakly ionized turbulent plasma. (auth)

12869 PARAMETRIC EXCITATION OF ION-SOUND INSTABILITY IN A MAGNETIZED PLASMA LOCATED IN A HIGH-FREQUENCY ELECTRIC FIELD. Nekrasov, F. M. (Physical-Technical Inst., Sukhumi, USSR). Nucl. Fusion; 9: 291-5(Dec 1969).

The stability of a magnetized nonisothermal ($T_e \gg T_i$) plasma in an alternating electric field when the field frequency Ω_0 is close to the frequency of the ion-acoustic oscillations of the plasma was investigated. The amplitude of the oscillatory velocity of electrons in a hf field is assumed to be small compared with their thermal velocity ($u_0 \ll v_{Te}$). It is shown that, for perturbations with wave number k_z satisfying the resonance condition $k_z^2 T_e / M_i = \Omega_0^2$ there exists in such a plasma an instability with a growth rate $\gamma \sim (u_0^2/v_{Te}^2)(k_z^2 T_e/M_i)^{1/2}$. The width of the instability zone is determined in the kinetic and hydrodynamic approximations. In the hydrodynamic approximation, if one does not allow for dissipation, there is instability however small the value of u_0^2/v_{Te}^2. If one allows for collisionless kinetic damping of the oscillations on the electrons, the instability develops only when u_0 exceeds come critical value $\sim v_{Te}(m_e/M_i)^{1/4}$. (auth)

12870 AMPLIFICATION OF NEUTRAL ACOUSTIC WAVES IN GASEOUS PLASMAS. Ishii, Tadao; Inuishi, Yoshio (Osaka Univ.). Jap. J. Appl. Phys.; 8: 1531-4(Dec 1969).

The amplification of neutral acoustic waves in gaseous plasmas consisting of three species of particles (neutron, ion, electron) is investigated. The calculations are done on the basis of the two kinds of assumptions: (1) the ion + neutral system is regarded as a continuous medium and is approximated by an elastic wave equation, and (2) each system (electron, ion, neutral) is treated hydrodynamically using Euler's equations. The two amplification constants obtained from the assumptions (1) and (2) are both the linear function of the electron drift velocity. Case (2) gives more strict information than case (1). The former is in more qualitative agreement with the experimental findings of Yatsui et al., provided that an injection of ultrasonic waves increases the collision frequency of the systems. (auth)

Shielding

Refer also to abstracts 12491 and 13632.

12871 (CTC-17) MUG: A PROGRAM FOR GENERATING MULTIGROUP PHOTON CROSS SECTIONS. Knight, J. R.; Mynatt, F. R. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). 20 Jan 1970. Contract W-7405-eng-26. 36p. Dep. CFSTI.

MUG is a FORTRAN IV program which generates multigroup photon cross sections suitable for use in discrete ordinate transport codes. The theory for the calculations is discussed, and the methods of obtaining energy group averaged scattering and absorption cross sections are described. A description of the input and output for the program is included. A sample problem is shown in the appendix. The MUG program was originally programmed for the IBM 7090 computer and put into operation in mid 1966. Subsequent conversion to the 360 computers and updating of the various options in the code have delayed formal publication. (auth)

12872 (LNF-69/27) MEASUREMENTS ON 1-GeV ELECTROMAGNETIC CASCADE AND CASCADE-PRODUCED NEUTRONS IN SHIELDING MATERIALS. Note No. 442. Lucci, F.; Pelliccioni, M.; Roccella, M. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 15 Apr 1969. 15p. Dep. CFSTI (U. S. Sales Only).

Some properties of electromagnetic showers induced by 600-MeV to 1-GeV bremsstrahlung γ rays were studied in ordinary concrete by thermoluminescent CaF_2 dosimeters. The experimental results are compared with measurements performed elsewhere in several materials. The attenuation of γ rays and cascade-produced neutrons in ordinary concrete and in lead and concrete heterogeneous absorbers were measured to obtain useful data for problems of shielding. (auth)

12873 (ORNL-TM-2751) ENERGY DISTRIBUTION OF PHOTONEUTRONS PRODUCED BY 150-MeV ELECTRONS IN THICK Be AND Ta TARGETS. Alsmiller, R. G. Jr.; Gabriel, T. A.; Guthrie, M. P. (Oak Ridge National Lab., Tenn.). Sept. 11, 1969. 27p. Dep. CFSTI.

Electron-photon cascade calculations and photoneutron-production calculations have been carried out for 150-MeV electrons on thick targets of Be and Ta. The calculated neutron-production spectra cover the energy range 0.01 MeV to approximately 100 MeV. Results on the photoproton-production spectra are also given. (auth)

12874 (ORNL-tr-2219) QUESTIONS ABOUT RADIATION. Dolezal, V.; Luxa, J. Translated for Oak Ridge National Lab., Tenn., from Radar (Prague), 1: 49-51(1968). 11p. Dep. CFSTI.

The information about ionizing radiation in outer space is summarized in the following categories: galactic cosmic radiation, ionizing radiation from solar eruptions, geomagnetically trapped particles, secondary radiation from interaction of primary particles with the materials of spaceship, and the possibility of instantaneous direct irradiation of spaceship crews by nuclear explosions. Permissible radiation doses are discussed in relation to these types of radiation in space. The radiation doses received to date by astronauts on their flights are reviewed. (M.H.R.)

12875 (ORNL-tr-2247) MEASUREMENT AND CALCULATION OF DOSE RATE REMOVAL CROSS-SECTIONS AND B-FACTORS OF NEUTRONS. Kolb, E.; Tschirf, E. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Acta Phys. Austr., 29: 160-5(1969). 7p. Dep. CFSTI.

The apparatus for the measurement of the dose rate removal cross section and the buildup factors with a Pu-Be source is sketched. The attenuating effect of water, oil, and paraffin was measured as a function of the thickness of layer up to 45 cm. The transmission factor was plotted as a function of the thickness of layer on a semilogarithmic coordinate system. The values of the buildup factors for the materials investigated are plotted as a function of the thickness of the absorbing layer. The values of the removal cross sections for the dose rate equivalent are tabulated. (M.H.R.)

12876 ANGULAR DISTRIBUTION OF THE BREMSSTRAHLUNG FROM THICK TARGETS AT LOW ENERGIES. Tsipenyuk, Yu. M. At. Energ. (USSR); 27: 468-70(Nov 1969). (In Russian).

No angular distribution measurements have been made on bremsstrahlung for electron energies below 17 MeV; therefore, in connection with photofission studies, the divergence of bremsstrahlung emitted by 1.0 and 0.11-mm thick W targets was measured at electron energies of 8.8 and 6.3 MeV, using a 2.1-cm^3 chamber with 3-mm thick Pb walls. The electron beam from the accelerating chamber was sent through a 0.25-mm thick Al foil to the target, placing a 2.5 koersted magnet behind it. The experimental data indicated that only in the high-energy portion of the spectrum is there a divergence from theoretical values. This divergence increases with the relative energy of the emitted γ quanta. It is shown that the angular distribution of the bremsstrahlung may be estimated with a precision of 10 to 15% by J. Lawson's formula up to target thicknesses of about 0.3 radiation length and electron energy above 5.0 MeV. At lower energies and with thin targets, the bremsstrahlung spectrum depends on the angle because of the inelastic interactions between electrons and matter. (TTT)

Solid-State Physics

Refer also to abstract 11548.

Radiation Effects

Refer also to abstracts 11496, 11872, 12494, and 13233.

12877 (IAE-1880) CONCERNING THE EFFECT OF THE NEUTRON SPECTRUM DURING IRRADIATION OF CRYSTALS. Ukhin, N. A.; Khrustalev, A. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1969. 47p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Calculation was carried out for the damage function g(E) in silicon, indicating the mean value of the secondary displacements due to the neutron interaction with the lattice atoms. This function was compared with similar functions calculated earlier by other authors. It is shown that the anisotropy of the neutron elastic dispersion and the high-energy neutron inelastic dispersion must be taken into account. Different damage functions took into consideration possible ways of including the neutron spectra in the radiation effects in silicon. It is shown that there is a threshold energy at which there was a small spectral dependence of the radiation damage. The value of the "optimum" threshold energy depends on the shape of the damage function. Using the damage function calculated for silicon, the value of the "optimum" threshold energy was 0.4 MeV. (auth)

12878 (N-69-37379) DEFECT PRODUCTION IN SINGLE CRYSTALS RESULTING FROM ION BOMBARDMENT. Semi-annual Status Report, July 1, 1968-June 30, 1969. Shaffer, Lawrence B. (Hiram Coll., Ohio. X-Ray Physics Lab.). 29 Aug 1969. 21p. (NASA-CR-105505; SASR-5). CFSTI.

Damage produced on the surface of metal single crystals during ion bombardment was investigated using ultrahigh vacuum x-ray techniques. Equipment delays are reported for the vacuum system and ion gun which delayed testing, as well as lack of local facilities for the necessary repairs. Only preliminary data are therefore available; these appear to indicate that the expected line broadening on copper and germanium due to ion damage is less than the precision of the measurement and possibly unmeasurably small. The future schedule includes damage studies in new copper crystals in renewed attempt to obtain double crystal topographs as a possibly more precise method of determining ion bombardment defects. (STAR)

12879 TOPOTACTIC DECOMPOSITION OF CADMIUM IODIDE IN THE BEAM OF AN ELECTRON MICROSCOPE. Guenter, John Ralph; Oswald, Hans Rudolf (Univ., Zurich). J. Microscop.; 8: 439-46(Jun 1969).

The radioinduced decomposition of CdI_2 as observed in a 75-kV electron beam is described. Visible changes in the crystals included creation of numerous dislocations and displacement of these, formation of holes with edges often oriented preferentially along crystallographic directions, movement of these holes, and precipitation of dark nuclei with oriented edges. These nuclei often contain moiré patterns. The diffraction pattern of an undecomposed crystal of CdI_2 iodide is hexagonal, if the platelets are in their usual position with their c axis parallel to the electron beam. After only a short exposure to the beam, additional diffraction spots appear, forming their own hexagonal net. By calculation of the d values they can be ascribed to metallic Cd in exactly parallel orientation to CdI_2, i.e., the axes a_{Cd} are parallel to a_{CdI_2} and c_{Cd} parallel to c_{CdI_2}. The decomposition of cadmium iodide proceeds by release of gaseous iodine and succeeding shrinkage of the (001) planes, connected with a slight translation (to obtain the requested Cd layer sequence) in the case of other polytypes than type C27. The release of iodine is initiated by collisions of electrons with iodide ions, producing neutral iodine atoms and secondary electrons. Cadmium is formed by a nucleation mechanism. The observed holes are the result of condensation of vacancies formed inside the crystals. (BBB)

12880 CARRIER CONCENTRATION PROFILES OF ION-IMPLANTED SILICON. Bader, R.; Kalbitzer, S. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Appl. Phys. Lett.; 16: 13-15(1 Jan 1970).

Sheet-resistivity and Hall-effect measurements on ion-implanted silicon wafers were performed. Carrier concentration profiles over the range of about 10^{19}-10^{11} carriers cm^3 were obtained for implants of 10^{14} ions/cm^2 of ^{11}B, ^{27}Al, and ^{31}P. Three regions, due to the different penetration mechanisms, could be clearly distinguished: the amorphous range, the channeling range, and the supertail. Some indication for a kinetic substitution mechanism is seen in the channeling region. (auth)

12881 RADIATION DAMAGE OF CRYSTALS IRRADIATED BY ATOMIC PARTICLES. Martynenko, Yu. V. Sov. Phys.-Solid State (Engl. Transl.); 11: 1582-5(Jan 1970).

Translated from Fiz. Tverd. Tela; 11: 1968-72(Jul 1969).

The kinetics of flow of point defects toward thermal spikes produced in crystals irradiated by atomic particles is discussed. It is shown that, with a sufficiently large radiation dose, the point-defect concentration is determined by this flow. The number of point defects that attach themselves to a thermal spike may be comparable to the number of atoms in the peak, i.e., under certain conditions the final dimensions of thermal spikes are governed by the number of point defects attached to them. (auth)

12882 EXCITATION OF SEMICONDUCTOR LASERS BY X-RAY AND GAMMA RADIATION. Molchanov, A. G.; Popov, Yu. M. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Solid State (Engl. Transl.); 11: 1580-1(Jan 1970).

Translated from Fiz. Tverd. Tela; 11: 1965-7(Jul 1969).

Excitation of semiconductor lasers by bremsstrahlung produced by electrons hitting a thick target and by gamma radiation from nuclear reactors is discussed. The long-wave behavior of the bremsstrahlung spectrum, which determines the generation depth in semiconductors, is calculated. It is shown that in order to increase significantly the generation depth of semiconductor lasers by x-ray and gamma radiation from the above-mentioned sources, one must cut off the long-wave portion of the spectrum. (auth)

12883 RADIATION-INDUCED ORIGIN AND GROWTH OF CLUSTERS OF INTERSTITIAL ATOMS. Agranovich, V. M.; Mikhlin, E. Ya. Sov. Phys.-Solid State (Engl. Transl.); 11: 1527-9(Jan 1970).

Translated from Fiz. Tverd. Tela; 11: 1895-8(Jul 1969).

A mechanism is set forth and analyzed for the origin and growth of clusters of interstitial atoms, simultaneously with formation and radiative annealing of vacancy zones. The growth of a cluster begins with a single interstitial atom and is due to trapping of dynamical crowdions on it. Equations are formulated which describe the kinetics of simultaneous accumulation of vacancy zones and clusters of interstitial atoms. The distribution function is found for these clusters and the vacancy zones with respect to the number of point defects contained in them. (auth)

12884 COLLOIDAL CENTERS IN IRRADIATED LiF:Mg CRYSTALS. Shvarts, K. K.; Lyushina, A. F.; Vitol, A. Ya. (Inst. of Physics, Riga). Sov. Phys.-Solid State (Engl. Transl.); 11: 1519-23(Jan 1970).

Translated from Fiz. Tverd. Tela; 11: 1885-90(Jul 1969).

The thermal annealing process for color centers in neutron-irradiated LiF crystals doped with magnesium of various concentrations (from 0.001 to 0.5 wt %) was investigated. The annealing process and the intensity of the 4.4-eV band depended strongly on the magnesium concentration. A comparison of the optical parameters of this band with plasma resonance theory shows it to be due to finely dispersed magnesium colloidal centers. (auth)

12885 EXTRINSIC PHOTOCONDUCTIVITY OF FAST-ELECTRON-IRRADIATED UNDOPED CdS SINGLE CRYSTALS. Wruck, D. (Zentralinstituts fuer Elektronenphysik, Berlin. Humboldt-Univ., Berlin). Phys. Status Solidi; 37: 165-80(1 Jan 1970).

The extrinsic photoconductivity of undoped platelet-type CdS crystals irradiated with 280-keV electrons was investigated at liquid nitrogen and room temperatures in the photon energy range 0.1 to 2.5 eV, using polarized light in the range 0.6 to 2.5 eV. A sensitive ac method was used, superimposing a chopped measuring beam on a constant bias illumination level. At least six photoconductivity bands were found. The bands in the range 0.6 to 2.5 eV are weakly polarized, the higher intensity occurring for $E \perp c$. The fine structure of the low-energy quenching band previously observed by Hemila and Bube was reproduced but was found to be caused by atmospheric absorption bands. Most of the bands in the photoconductivity spectrum correspond to absorption bands found by Boyn in thick crystals. The present results, assuming the threshold energies for atomic displacement in CdS determined by Kulp and Kelley to be valid, together with the results of trap analysis, absorption measurements, and earlier investigations of the trap spectrum, electron lifetime, and dark conductivity of deuteron-bombarded CdS crystals suggest an assignment of the photoconductivity bands to intrinsic lattice defects and to donor-acceptor associates involving intrinsic defects and residual impurities. (auth)

12886 THERMALLY STIMULATED CONDUCTIVITY OF IRRADIATED KBr. Taylor, A. (Cornell Univ., Ithaca, N. Y.). Phys. Status Solidi; 37: 401-12(1 Jan 1970).

The thermally stimulated conductivity of KBr crystals irradiated at 10°K with monoenergetic (500-keV) neutrons and γ rays was studied over the temperature range 10 to 300°K. The peak spectrum below 70°K was associated with the annihilation of lattice defects created by the irradiation, while the higher-temperature peaks were interpreted as due to the depopulation of impurity traps. The annealing kinetics of the low-temperature peak were consistent with defect annihilation processes controlled by the migration of the Br^- interstitials. Neutron bombardment enhanced significantly the low-temperature peaks above the level established by background γ rays. (auth)

12887 CONTRIBUTION TO SPUTTERING OF SECONDARY COLLISIONS BETWEEN BOMBARDING IONS AND TARGET ATOMS. Odintsov, D. D. Sov. Phys.-Solid State (Engl. Transl.); 11: 1656-7(Jan 1970).

Translated from Fiz. Tverd. Tela; 11: 2045-7(Jul 1969).

Models for allowing for secondary and subsequent collisions between incoming ions and crystal atoms are considered briefly. The Yurasova-Bukhanov experiment, in which the ratio of the intensities of two Venera spots (directions of identical indices but different angles with ion incidence angle) is measured, provides a clear picture of these secondary collisions. The microscopic point of view of the process is described. (D.L.C.)

12888 SURFACE DAMAGE BY ION BOMBARDMENT. Buswell, J. T. (Central Electricity Generating Board, Berkeley, Eng.). Phil. Mag.; 21: 357-64(Feb 1970).

Irradiation of tungsten field ion microscope tips with 150-keV Hg^+ ions produces damage consisting of surface craters and underlying voids resulting from the occurrence of collision cascades close to the specimen surfaces. Damage occurs predominantly on the beam-incident size. The distribution of the damage depends on the size and shape of the tips and the range of the incident ions. Approximately 5% of the ions penetrate the tip to produce damage on the shielded side. Observations on extra bright spots present close to the irradiated surface and planar defects extending into the tips from the irradiated surface are considered. (auth)(UK)

12889 INFRARED ABSORPTION IN IRRADIATED SILICON AND GERMANIUM. Matsumura, Hiroshi (Tokai Univ., Tokyo). Tokai Daigaku Kiyo Kogakubu; 4: No. 1-2, 33-47(Mar 1969).

The effect of epithermal neutrons and ^{60}Co gamma rays on infrared absorption spectra of silicon and germanium at room temperature was studied. No significant effect of neutrons nor of gamma rays was detected in low-resistivity germanium at this temperature. In silicon, the intensity of the 9-μ band due to oxygen impurity was found to decrease slowly with the integrated neutron flux. Upon annealing, the 9-μ band was observed to be significantly affected by a neutron flux of the order of 10^{16} n/cm^2. The 16.5-μ band observed in silicon was found to be independent of oxygen concentration and its possible source of absorption was suggested. Annealing of these two bands caused suppression and a slight shift of the absorption bands, sometimes accompanied by the production of "satellite" bands. Little effect of gamma rays was observed except for a wavelength shift and a decrease in 16.4 μ when annealed at 75°C. (auth)(NSA of Japan)

Physical Properties

Refer also to abstracts 12415 and 12631.

12890 (IA-1190, pp 33-86) SOLID STATE PHYSICS AND METALLURGY. (Israel Atomic Energy Commission, Tel Aviv).

Most of the material reported in this section was submitted to various journals for publication; practically all material in scope for NSA was cataloged from those sources. Significant data apparently not published are included on: (1) self-diffusion in vanadium metal, and (2) transmission electron microscopy of WO_3 after formation of oxide films on tungsten foils by anodic treatment. (L.M.T.)

12891 (RISO-M-961) SEMI-ANNUAL REPORT FOR THE PERIOD 1st JANUARY-30th JUNE 1969. Moeller, H. Bjerrum (Danish Atomic Energy Commission, Risoe. Research Establishment). Oct 1969. 18p. Dep. CFSTI (U. S. Sales Only).

BRASS—magnetic long-range order in beta-
CHROMIUM—magnetic structure of nitrogen-containing
HOLMIUM—magnetic structure of
HOLMIUM ALLOYS & SYSTEMS—Ho-base-Tb, spin-wave dispersion in
—Ho-base-Tb, magnetic structure of
MAGNETIC MATERIALS—critical fluctuations at high temperatures, Green's function theory of
MAGNETIC MIRROR MACHINES—measurements on positive and negative center electrodes in Puffatron
MANGANESE FLUORIDES—magnetic critical scattering of neutrons in MnF_2
METEOROLOGY—tower instrumentation and studies at Risoe, Denmark
PLASMA—rotation in Puffatron device
PLUTONIUM—proton and deuteron stopping power measurements
Q DEVICES—experiments in
SHOCK TUBES—current sheet speeds in magnetically driven
TERBIUM—magnetic anisotropy of
—magnetic critical scattering of neutrons in
URANIUM—proton and deuteron stopping power measurements (D.L.C.)

12892 ANISOTROPY OF THE HALL EFFECT AND THE ELECTRIC RESISTANCE OF A SCANDIUM SINGLE CRYSTAL. Volkov, D. I.; Prudnikov, V. N.; Kozlova, T. M.; Naumkin, O. P. (Moscow State Univ.). Zh. Eksp. Teor. Fiz.; 57: 1894-8(Dec 1969). (In Russian).

Anisotropy of the Hall effect and of the electric resistance of a scandium single crystal is investigated at temperatures between 77 and 300°K. It is found that the effective Hall constant during magnetization of the crystal along the hexagonal axis varies with the temperature as T^2 and for magnetization perpendicular to the axis as ~1/T. The difference in the temperature dependence of the Hall effect is ascribed to the influence of the anomalous part of the Hall field. The temperature dependence of the electric resistance is not linear and this fact is explained by the effect of s-d electron scattering. (auth)

12893 THE ANALYSIS OF MONOMOLECULAR LAYERS OF SOLIDS BY SECONDARY ION EMISSION. Benninghoven, A. (Univ., Cologne). Z. Phys.; 230: 403-17(1970). (In German).

The use of extremely low primary ion current densities (10^{-9} A cm^{-2}) increases the sputtering time of the original first monolayer of a solid to such a degree (>10^4 sec), that the analysis of this layer by secondary ion spectroscopy can be realized. Changes in its composition (caused by surface reactions, particle bombardment etc.) can be observed for a long period before a considerable fraction of the surface has interacted with the weak ion beam. The capacity of the method is demonstrated by analysis results of Ag and Mo surfaces. Many kinds of ions follow exactly the time dependence $N(t) = N(0)\, e^{-t/T}$, characteristic exclusively for ions originating from components present only in the first monolayer. The detection limit for several complex anions is below 1 ppM of a monolayer (<10^{-15} g). This method of monolayer analysis shows some advantages compared with electron probe x-ray analysis or Auger electron spectroscopy: Isotope separation, detection of changes of concentration within the first few monolayers, and especially the detection of chemical compounds. (auth)

12894 EFFECT OF MAGNETIC-FIELD COOLING THROUGH THE ANOMALY TEMPERATURE IN VANADIUM METAL. Chiba, Toshinobu; Mitsui, Tadayasu (Hokkaido Univ., Sapporo). J. Phys. Soc. Jap.; 27: 1451-4(Dec 1969).

The effect of magnetic-field cooling was measured on a single crystal of vanadium metal of 99.9% purity using a sensitive torque magnetometer. It was found that uniaxial anisotropy with the easy axis parallel to the cooling field was induced by the magnetic-field cooling from 300°K down through the anomaly temperature to 87°K with cooling field 13 kOe, and that the induced anisotropy disappeared precipitously when the specimen was heated up to 280°K, which is ascribed to the anomaly temperature of this specimen. It is suggested that the anisotropy is due to the preferably oriented phase of vanadium hydride which has small spontaneous magnetization. (auth)

12895 CORE ANNIHILATION OF POSITRONS IN METALS. Garg, J. C.; Saraf, B. L. (Univ. of Rajasthan, Jaipur, India). J. Phys. Soc. Jap.; 27: 1695(Dec 1969).

Valence and core enhancement factors due to positron-electron interactions were calculated for Na, Al, and Cu. The calculated core rates for Al and Cu agree well with one-electron rates, while for Na, the core rate is consistent with many-body calculations, suggesting that the core enhancement factor plays a larger role in metals of low electron density. (D.L.C.)

12896 A MECHANISM OF THE POSITRON ANNIHILATION PROCESS IN REAL METALS. Garg, J. C.; Saraf, B. L. (Univ. of Rajasthan, Jaipur, India). J. Phys. Soc. Jap.; 27: 1697(Dec 1969).

It is proposed that in conduction electron gas (metals), a positron may form a bound state, a quasi-bound state, or annihilate freely, depending on the density of the gas. The bound state will be formed if there is room to accommodate it ($r_s \geq X$), and it is a spin-averaged positronium atom decaying at a rate $R_{pos} = 2 \times 10^9$ sec^{-1}. At higher density (lower r_s), the wave function of the bound state overlaps with that of the electron, and the positron annihilates through "pick off." The equation for the mean annihilation rate is derived as $R_v = R_{pos} + 2R_0\,(1 - r_s^3 \times X^3)$ for $r_s < X$, where $R_0 = 12.05\, r_s^{-3} \times 10^9$ sec^{-1}, the Sommerfeld rate. (D.L.C.)

12897 THEORY OF THE GALVANOMAGNETIC EFFECTS IN GRAPHITE. Kechin, V. V. (Inst. of High-Pressure Physics, Moscow). Sov. Phys.-Solid State (Engl. Transl.); 11: 1448-55 (Jan 1970).

Translated from Fiz. Tverd. Tela; 11: 1788-99(Jul 1969).

The theory of the galvanomagnetic properties of graphite is derived for the Slonczewski-Weiss model of the energy spectrum in a relaxation-time approximation, for all temperatures and for both pure and impure graphite. Comparison with experimentally derived equations in the limit of small magnetic fields yields the following spectral parameters: $\gamma_5^2\gamma_2/\gamma_1 = -0.336$ eV^2, $\gamma_4/\gamma_5\gamma_2 = -3.67$ eV^{-1}, and $|\gamma_5^2/\gamma_1| = 23.4$ eV. It is concluded that $\gamma_2 < 0$, $\gamma_4 > 0$, and $\Delta > 0$, and that the regions of the Fermi surface previously assigned to holes and electrons should be interchanged. (auth)

12898 ELECTRONIC TRANSITIONS IN HAFNIUM, EUROPIUM, AND YTTERBIUM AT HIGH PRESSURES. Bakanova,

A. A.; Dudoladov, I. P.; Sutulov, Yu. N. Sov. Phys.-Solid State (Engl. Transl.); 11: 1515-18(Jan 1970).

Translated from Fiz. Tverd. Tela; 11: 1881-4(Jul 1969).

The shock compressibilities of europium, ytterbium, and hafnium have been studied in a wide range of pressures from 100 kbars to 3 to 4 Mbars. Upon reaching certain critical pressures, the adiabatic curves of these metals undergo breaks, which are accompanied by a discontinuous decrease in compressibility. Similarly to previously studied lanthanides and transition metals having low electron densities in the d levels, the breaks are explained by electronic transitions: shifts of s electrons to inner d levels. (auth)

12899 ELECTRONIC STRUCTURE AND PHASE TRANSITIONS IN YTTERBIUM. Johansen, G.; Mackintosh, A. R. (Technical Univ., Lyngby, Denmark). Solid State Commun.; 8: 121-4(Jan 1970).

The energy band structure of Yb was calculated as a function of volume by the RAPW method. Although the relative position of the 5d bands is not greatly affected by compression, they broaden substantially, and it is suggested that this causes the metal–semiconductor and $\alpha-\beta$ phase transitions. Narrow 4f bands, whose position is very uncertain, are found near the bottom of the conduction bands. (auth) (UK)

12900 THERMOELECTRIC POWER OF ANNEALED AND STRAINED EUROPIUM METAL BETWEEN 10 AND 300°K. Meaden, G. T.; Sze, N. H. (Dalhousie Univ., Halifax, Nova Scotia). J. Low Temp. Phys.; 1: 567-76(Dec 1969).

The thermoelectric power of europium has been determined between 10 and 300°K using samples in the well-annealed, as-received, and highly strained conditions. The effect on the thermoelectric power of the transition of antiferromagnetism below 88.8 ± 0.1°K and of magnon drag at lower temperatures is discussed and compared with deductions made from accompanying resistivity data. The temperature at which a small anomaly, caused by an impurity, occurs in the most strained sample (25°K) is lowered to 18°K as the sample strain and probably also hydrogen contamination decreases. The nature of this behavior is discussed. (auth)

12901 CLEAR EVIDENCE FOR THE SPIN-WAVE ENERGY GAP IN TERBIUM. Sze, N. H.; Rao, K. V.; Meaden, G. T. (Dalhousie Univ., Halifax, Nova Scotia). J. Low Temp. Phys.; 1: 563-6(Dec 1969).

Electrical resistivity measurements on single-crystal terbium oriented along the c axis show the spin–wave energy gap at 21.5°K. The total resistivity fits the equation $\rho = \rho_0 = 2.43 \times 10^{-7}\ T^5$ $2.544 \times 10^{-3}\ T^2 \exp(21.5/T)\ \mu\Omega$-cm in the temperature region below 21.5°K. (auth)

12902 THE CALCULATION OF THE PIEZOABSORPTION OF GRAPHITE IN ULTRAVIOLET REGION. Imatake, Akiko; Uemura, Yasutada (Tokyo Univ.). J. Phys. Soc. Jap.; 28: 410-18(Feb 1970).

A formula which is convenient for the calculation of piezoabsorption spectrum is derived. By applying the formula to the π bands of graphite, the piezoabsorption near the 4.8-eV peak is calculated numerically, and some corrections of the previous result for the absorption are also made. The results are compared with those of thermoreflectance measurements; discrepancies between the theory and the experiment are discussed in connection with the choice of band model. (auth)

12903 LATTICE DYNAMICS OF HEXAGONAL METALS BASED ON A NEW ELECTRON–ION INTERACTION. Sharan, B.; Bajpai, R. P. (Indian Inst. of Tech., New Delhi). J. Phys. Soc. Jap.; 28: 338-45(Feb 1970).

A new approach to the lattice dynamics of hexagonal metals is presented in which the electron–ion contribution is introduced in a manner outlined recently by the authors. Three metals with different axial (c/a) ratios are considered: beryllium (1.568), magnesium (1.624), and thallium (1.597). The ion–ion interaction is restricted up to the fifth neighbors for beryllium and up to the fourth neighbors for magnesium and thallium. The force constants are related to the elastic constants in the long-wavelength limit. The dispersion curves were drawn for [0001] and [01$\bar{1}$0] directions for all the three metals and are found to be in satisfactory agreement with the results of neutron scattering on beryllium and magnesium. No comparison was made for thallium for lack of experimental data on it. (auth)

12904 DETERMINATION OF THE ENERGY GAP AND THE ENERGY LEVELS OF ACCEPTORS IN NATURAL URANIUM DIOXIDE. Sorriaux, Andre (Institut National des Sciences et Techniques Nucleaires, Saclay, France). Compt. Rend., Ser. B; 270: 77-9(5 Jan 1970).

The experiment was carried out with cold-pressed uranium dioxide, between 285 and 770°K. The measurement of the sample electrical resistance leads to the determination of three activation energies: 0.1533 ± 0.003 eV, 0.25 ± 0.026 eV, and 1.21 ± 0.15 eV. These results are nearly the same as those obtained with single crystals. (France)

Moessbauer Effects and NMR

Refer also to abstracts 11825, 11834, 11873, 11875, 12769, and 13348.

12905 (IS-520(Rev.)) CATALOG OF NUCLEAR QUADRUPOLE INTERACTIONS AND RESONANCE FREQUENCIES IN SOLIDS. PART I. ELEMENTS AND INORGANIC COMPOUNDS. Segel, S. L.; Barnes, R. G. (Ames Lab., Iowa). Apr 1968. Contract W-7405-eng-82. 126p. Dep. CFSTI.

This catalog lists quadrupole resonance frequencies and coupling constants for the following categories of compounds: non-halogen nuclei, chlorides, bromides, iodides, chlorates, bromates, and iodates. Some organic compounds, in particular nitrogen compounds, are also included. References are included, and a list of quadrupole moment ratios is provided for calculating coupling constants for alternative isotopes. The data were obtained from NMR, Moessbauer effect, and specific heat measurements. (D.L.C.)

12906 NUCLEAR MAGNETIC RESONANCE AND MAGNETIC SUSCEPTIBILITY OF Pr_3Al_{11}, Nd_3Al_{11}, AND $EuAl_4$. van Diepen, A. M. (Univ., Amsterdam); Buschow, K. H. J.; de Wijn, H. W. J. Chem. Phys.; 51: 5259-63(15 Dec 1969).

The Knight shifts of the ^{27}Al NMR in Pr_3Al_{11}, Nd_3Al_{11}, and $EuAl_4$ were measured between 86 and 300°K and found to be different for inequivalent Al sites. The results are discussed in terms of the Ruderman–Kittel–Kasuya–Yosida theory. The magnetic susceptibilities were measured in the temperature region from 300 down to 4.2°K, and found to deviate from Curie–Weiss laws only for temperatures lower than 40°K. (auth)

12907 INTERFERENCE OF NUCLEAR RESONANCE ELECTRON PRODUCTION AND PHOTOEFFECT FOR MOESSBAUER E2 AND M1 γ RAYS. Afanas'ev, A. M.; Kagan, Yu. (Kurchatov Inst. of Atomic Energy, Moscow). Phys. Lett.; 31A: 38-9(Jan. 12, 1970).

It is shown that this type of interference can display itself for E2 and M1 nuclear transitions if one studies the angular distribution of the electron produced by the γ rays rather than the total absorption. (auth)

12908 KNIGHT SHIFT AND SUSCEPTIBILITY IN $SmSn_3$ AND $SmPt_2$. Malik, S. K. (Tata Inst. of Fundamental Research, Bombay). Phys. Lett.; 31A: 33-4(12 Jan 1970).

^{195}Pt Knight shift in $SmPt_2$ which is proportional to the Sm^{3+} spin $\langle S(T)\rangle$ has been observed to reverse its sign at 240°K. No such reversal for ^{119}Sn has been observed in $SmSn_3$. The susceptibility of $SmSn_3$ has been analysed in order to understand the behavior of ^{119}Sn Knight shift. (auth)

12909 TEMPERATURE DEPENDENCE OF THE VANADIUM NMR FREQUENCY SHIFT IN V_2O_3. Jones, E. D. (Sandia Labs., Albuquerque, N. Mex.). J. Phys. Soc. Jap.; 27: 1692-3 (Dec 1969).

The temperature dependence of the Knight shift of the vanadium NMR in V_2O_3 was remeasured between 300 and 600°K. A plot of $[K(T) - K_c]^{-1}$ vs T gives a straight line with $C = 0.70 \pm 0.02$ emn/mole °K and $\theta = -684 \pm 29$°K. The discrepancy between these measurements and the susceptibility, reported to be temperature independent between 400 and 600°K, is discussed. (D.L.C.)

12910 COMBINED ASYMMETRIC KNIGHT SHIFT AND QUADRUPOLE EFFECTS IN THE NUCLEAR MAGNETIC RESONANCE SPECTRUM OF $ScMn_2$. Barnes, R. G.; Lunde, B. K. (Ames Lab., Iowa). J. Phys. Soc. Jap.; 28: 408-9(Feb 1970).

Measurements of the Knight shift and quadrupole coupling parameters of the ^{45}Sc and ^{55}Mn nuclear magnetic resonances are reported for the hexagonal Laves phase compound $ScMn_2$. This spectrum furnishes an example in which combined Knight shift and quadrupole interactions of less-than-axial symmetry occur. (auth)

12911 ENVIRONMENTAL EFFECTS ON THE ELECTRON CAPTURE DECAY RATE. Alder, K.; Hadermann, J.; Raff, U. (Univ. of Basel). Phys. Lett., 30A: 487-8(29 Dec 1969).

The change of the lifetime in electron capture of ^{89}Zr in different environments ($BaTiO_3$) is discussed. (auth)

12912 NMR ANISOTROPY IN IRRADIATED LITHIUM HYDRIDE. Souers, P. C.; Blake, T. S.; Penpraze, R. M. (Univ. of California, Livermore). Phil. Mag.; 21: 287-92(Feb 1970).

Lithium hydride single crystals irradiated with ^{60}Co gamma rays show a motionally narrowed hydrogen signal to pulsed NMR measurements. The transverse relaxation time of this signal shows a marked angular dependence as an oriented crystal is rotated relative to the magnetic field. This orientation effect is considered to be due to wall relaxation of hydrogen gas in cubic bubbles. That portion of the transverse relaxation time caused by wall interactions is shown to be proportional to the dipolar relation $(1 - 3\cos^2\alpha)^{-1}$, where α is the laboratory angle of rotation. The longitudinal relaxation time is not affected by crystal rotation. (auth)(UK)

Theory

12913 SOLID-STATE THEORY: METHODS AND APPLICATIONS. Landsberg, P. T. (ed.). New York; John Wiley and Sons, Inc. (1969). 539p. $24.95.

This book, intended for the first postgraduate year, displays a variety of mathematical techniques. The thirteen chapters are concerned with typical experiments and their interpretation, electrons in perfect crystals, group theory, electron statistics and devices, lattice vibration theory, and Green's functions. (D.L.C.)

Theoretical Physics

Refer also to abstracts 13147 and 13198.

12914 (AD-695410) DIFFICULTY AND POSSIBILITY OF KINETIC THEORY OF QUANTUM-MECHANICAL SYSTEMS. Koga, Toyoki (Polytechnic Inst. of Brooklyn, N. Y. Dept. of Aerospace Engineering and Applied Mechanics). May 1969. 53p. (PIBAL-69-17). CFSTI.

In kinetic theory which intends to treat the evolution, in time and in configuration space, of a system not in thermal equilibrium, it is necessary to consider correlative behaviors of constituent particles or correlations among elementary behaviors of the system. Correlative behaviors are conceivable only when each elementary behavior is distinguishable from the others. In the quantum-mechanical formalism, first, the uncertainty principle prohibits a particle following a completely prescribable path; second, due to the symmetry (bosons) or antisymmetry (fermions) principle, each particle exists at many states, as many as similar particles in a system, at the same time. Therefore, it is impossible to consider kinetic theory as in accordance with the quantum-mechanical formalism. Nevertheless, evidences of kinetic-theoretical processes occurring in quantum-mechanical systems are pointed out. Also evidences of limited range (in time and in configuration space) of validity of the symmetry or antisymmetry principle are indicated. (auth) (USGRDR)

12915 AN EXACTLY SOLUBLE MODEL FOR THE TIME DEVELOPMENT OF MANY-BODY-QUANTUM SYSTEMS WITH INTERACTION. Wild, Wolfgang (Technische Hochschule, Munich). Z. Phys.; 229: 230-42(1969). (In German).

A model of a quantum mechanical system with an extremely simplified energy spectrum of the unperturbed Hamiltonian and a separable residual interaction, which can be solved exactly and in closed analytical form, is analyzed with respect to its variation in time. The influence of the initial condition, of the strength and range of the residual interaction and of the level spacing of the unperturbed system is investigated. Special interest is dedicated to the question, under which conditions and to which extent the model approaches a stationary equilibrium state. (auth)

12916 COMPARISON BETWEEN TWO FORMULATIONS OF STOCHASTIC QUANTUM MECHANICS. de la Pena-Auerbach, L.; Velasco, Rosa M. (Univ. Nacional de Mexico, Mexico City). Rev. Mex. Fis.; 18: 397-406(1969).

The stochastic theory of quantum mechanics proposed by Kershaw (Phys. Rev., 136B: 1850(1964)) is revised to eliminate an internal inconsistency contained in it; by doing this, one recovers the theory recently proposed by one of the authors (L. de la. Pena-Auerbach). (auth)

12917 PHASE OPERATOR FOR THE HARMONIC OSCILLATOR. Varga, B. B.; Aks, S. Oe. (Univ. of Illinois, Chicago). Phys. Lett.; 31A: 40-1(12 Jan 1970).

A physically meaningful quantum-mechanical phase operator is constructed for the harmonic oscillator. The phase operator is an exact canonical conjugate to the number operator, and becomes the appropriate phase angle in the classical limit. (auth)

12918 MASS SPECTRA AND CLASSICAL DYNAMICS. Schiller, Ralph; Jacobi, Lee (Stevens Inst. of Tech., Hoboken, N. J.). Phys. Rev.; 186: 1360-7(25 Oct 1969).

The concept of mass is analyzed in classical relativistic dynamics. For particles with internal degrees of freedom, the law of inertia fails, and the momentum vector and velocity vector are no longer parallel. As a consequence, the inertial mass and kinematic mass energy differ in magnitude. In addition, the requirement that the velocity vector be timelike or null does not impose the same restriction on the momentum vector. Three different classes of theories are analyzed: those whose internal degrees of freedom are described by the de Sitter, complex Lorentz, and conformal groups. It is assumed that the dynamical variables satisfy certain nonholonomic constraints as identities. These constraints couple the space-time trajectory to the internal variables. As a consequence of this coupling, the kinematic mass energy depends on certain classical constants of the motion. Simple correspondence-principle arguments show that the analogous quantum theories exhibit discrete and infinite mass spectra. (auth)

12919 QUANTUM THEORY OF A RANDOMLY MODULATED HARMONIC OSCILLATOR. Crosignani, Bruno (Istituto Superiore Poste e Telecomunicazioni, Rome); Di Porto, Paolo; Solimeno, Salvatore. Phys. Rev.; 186: 1342-7(25 Oct 1969).

The time evolution of a randomly modulated quantum harmonic oscillator is studied by introducing the master equation for the reduced density operator $s(t)$. The antinormally ordered representation is adopted for $s(t)$, and one is thus confronted with the problem of solving the partial differential equation obeyed by the reduced matrix element $\hat{s}$ of $s(t)$. The two limiting cases of short- and long-range correlations of the frequency fluctuations are treated in detail. (auth)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Electromagnetic

Refer also to abstract 12997.

12920 (IFA-NR-30) UPPER LIMIT OF THE ELECTRIC DIPOLE MOMENT OF THE NEUTRON. Apostolescu, S.; Ionescu, D. R.; Ionescu-Bujor, M.; Meitert, S.; Petrascu, M. (Academia R. S. R., Bucharest, Institutul de Fizica Atomica). 1969. 16p. Dep. CFSTI (U. S. Sales Only).

The neutron magnetic resonance has been used in the determination of the electric dipole moment of the neutron. An improved spectrometer has been used having 1.8 meters distance between the rf coils and an elaborate magnetic shielding consisting in eight strata of ARMCO iron. The electric field was 95 kV/cm. No value of the electric dipole moment could be put into evidence in the limits of the errors, so a value of $(-0.2 \pm 3.9) \times 10^{-22}$ cm for μ_e/e has been established, in good agreement with previous results. (auth)

12921 ON PION ELECTROPRODUCTION AT 5 fm^{-2} NEAR THRESHOLD. Amaldi, E. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome); Borgia, B.; Pistilli, P.; Balla, M.; Di Giorgio, G. V.; Giazotto, A.; Serbassi, S.; Stoppini, G. Nuovo Cim.; 65A: 377-96(21 Jan 1970).

A preliminary coincidence experiment designed for determining the electroproduction cross section at threshold is described. At a four-momentum transfer $-k^2 = 0.2(GeV/c)^2$ and a polarization of the exchanged virtual photon $\epsilon = 0.74$, one finds for π^+ $\lim_{q^* \to 0}[(1/q^*)(d\sigma/d\omega_e dr_{02})]_{\pi^+} = 4.9 \cdot 10^{-31}$ $cm^2/(sr \cdot (GeV)^2/c)(\pm 14\%)$, where q^* is the three-momentum of the pion in the frame of the c.m. of the (pion + nucleon) system observed in the final state. This value of the cross section agrees with the theoretical value obtained in Born approximation. Two different approaches can be adopted for interpreting this result. The first one, based on a formula derived by De Tollis and Nicolò by considering only Born terms in a double dispersion theory, allows a determination of the pion form factors F_π. By this method one obtains $F_\pi(0.2) = 0.80^{+0.20}_{-0.25}$ if one takes $G_{E_0}(0.2) = 0$. The second approach, based on current algebra and PCAC assumption, allows a determination of the axial vector form factor G_A of the nucleon, which, however, depends on the procedure followed to correct for the finite mass of the pion. For example, by using the Gleeson et al. formula and $G_{E_0} = 0$, one obtains $G_A/g_A = 0.760 \pm 0.055$. Assuming for G_A the dipole approximation, one derives $M_A = (1.17 \pm 0.07)$GeV. From the measurements of the π^0 electroproduction only a very low upper limit of the cross section at threshold can be derived. The cross section, however, increases rapidly with q^* reaching a value equal to about 30% of the π^+ cross section already at q^* around 50 MeV/c. (auth)

12922 MESON PRODUCTION BY HIGH-ENERGY ELECTRONS AND MUONS. Thompson, Richard Louis. Seattle; Univ. of Washington (1968). 110p.

Thesis.

An investigation of meson production in nuclear emulsion by high energy electrons and muons was made. Stacks of Ilford, G-5, nuclear emulsion pellicles were exposed to 10.0- and 16.0-GeV electrons at the Stanford Linear Accelerator, and a 10.5-GeV exposure of positive muons was obtained at the Brookhaven A.G.S. The emulsions were area scanned for inelastic interactions, and the angle of scattering was measured for all lepton induced events. Total and differential cross sections were determined for the process and the results compared with cross sections calculated on the basis of the theoretical expressions of Hand and Wilson. The results for the electrons are in very good agreement with the calculations, giving an average contribution of 12% of the cross section from the scalar photon cross section. This average contribution is consistent with the scalar photon cross sections which were measured in other experiments. For the muons, the experimental cross sections are found to be too large in comparison to the electron results. The ratio of the electron total cross section to the muon total cross section at 10.0 GeV is measured to be 2.49 ± 0.46 as compared to the calculated ratio of 3.6. Evidently the difficulty cannot be explained by experimental errors and may possibly arise from the intrusion of a new process for the muon. (Diss. Abstr.)

12923 IONIZATION-ENERGY RELATION FOR RELATIVISTIC PARTICLES IN NUCLEAR EMULSIONS. Tsai-Chu (Faculte des Sciences, Paris). Compt. Rend., Ser. B; 269: 781-4(20 Oct 1969). (In French).

The ratio between grain densities at the plateau value and at minimum is 1.138 ± 0.010. The experimental and theoretical analysis shows the presence of 20% of secondary grains at the ionization minimum. (tr-auth)

12924 COHERENT PHOTOPRODUCTION OF π^0 ON HELIUM. Lefrancois, J.; Lehmann, P.; Repellin, J. P. (Ecole Normale Superieure, Orsay, France). Nuovo Cim.; 65A: 333-46(21 Jan 1970).

The coherent photoproduction cross section of π^0 on helium was measured for five values of the squared momentum transfer from 3 to 6.7 fm^{-2} and for gamma-ray energy from 260 to 800 MeV. The results are compared with simple impulse-approximation calculation limited to the contribution of the first resonance $P_{\frac{3}{2}\frac{3}{2}}$ which appears clearly but is strongly depressed due to rescattering effects. A good agreement with data is obtained between 450 and 650 gamma-ray energy by using a nuclear distribution 6% more concentrated than the proton distribution in helium. This indicates that there is no evidence of the contribution of the $P_{\frac{3}{2}\frac{1}{2}}$ or $D_{\frac{3}{2}\frac{3}{2}}$ waves. (auth)

12925 PHOTOPRODUCTION OF π^+ MESONS BY LINEARLY POLARIZED PHOTONS. Kuznetsov, V. M.; Studkov, O. I.; Repenko, E. V.; Sertakov, Yu. I. (Nuclear Physics Research Inst., Tomsk, USSR). JETP Lett. (USSR) (Engl. Transl.); 10: 174-5(20 Sep 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu; 10: 273-5(20 Sep 1969).

A polarized photon beam obtained with the Sirius synchrotron was used to study the $\gamma p \to \pi^+ n$ interactions at photon energies of 229 to 258 MeV. Asymmetry values calculated on the basis of 2500 selected events are given. (L.B.S.)

12926 RESTRICTED ENERGY LOSS BY IONIZATION FOR ULTRARELATIVISTIC PARTICLES IN NUCLEAR EMULSION. Congel, Frank J. Potsdam, N. Y.; Clarkson Coll. of Tech. (1969). 112 p.

Thesis.

The variation of the grain density as a function of particle velocity was investigated for relativistic velocities ($1/\sqrt{(1-v^2/c^2)} > 4$) using Ilford K-5 emulsions. The two pellicles had been exposed to beams of 5-, 8-, 12-, and 24-BeV/c protons as well as 5 BeV/c pions which intersected in a small area ($2cm^2$) of each emulsion. Blob counting was done by a single experienced observer who counted about 80,000 blobs for each beam. This amount of statistics allowed for a precise depth versus blob density profile determination. The blob densities were subsequently converted to grain densities using the method of O'Ceallaigh. The results of both pellicles are in agreement with the Sternheimer formula for the restricted energy loss with a cut-off energy $T_0 = 7$ keV and a mean ionization potential I = 434 eV. These two calibrated pellicles were also exposed to a bremsstrahlung beam yielding electron-positron pairs in the same small carefully calibrated area of each pellicle. Using the combined depth profile of the blob density of the 5 calibration beams, careful corrections for variation of the grain density with depth were made. The energies of the electrons were measured by scattering on a Koristka scattering microscope. The electron results are consistent with the predictions of Sternheimer formula with I = 434 eV and $T_0 = 11$ keV and will be shown to be in good agreement with both theory and the experimental results on the relativistic plateau and the ratio of the asymptotic value of the grain density to the grain density at minimum (1.155) will be shown to be in disagreement with the prediction of Tsytovitch of a serious radiative correction. (Diss. Abstr.)

12927 ELECTRON-INDUCED CASCADE SHOWERS IN LEAD, COPPER, AND ALUMINUM. Yuda, T. (Nagoya Univ., Japan); Masaike, A.; Kusumegi, A.; Murata, Y.; Ohta, I.; Nishimura, J. Nuovo Cim.; 65A: 205-28(1 Jan 1970).

Cascade showers induced by 600 MeV and 1000 MeV electrons have been studied in lead, copper and aluminium, with X-ray films inserted between absorber plates. The application of photographic films for the investigation of shower properties has the following advantages. First, the film thickness is quite thin so that it gives little effect on the homogeneity of the absorber plates. Second, they enable us to make an overall observation of the shower behavior by single exposure. The observed lateral and longitudinal distributions of energy loss in the shower are compared with the

shower theory under the approximation B. To determine the efficiency of a total-absorption-type detector, the fraction of the incident energy escaping from the surface of the cylinders, or that from the bottom of the cylinders can be calculated from our data. The results are also compared with the Monte Carlo calculations as well as with the data obtained by other workers. (auth)

12928 COMMENTS ON "EVIDENCE OF QUARKS IN AIR-SHOWER CORES". Rahm, D. C.; Louttit, R. I. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett.; 24: 279-82(9 Feb 1970).

McCusker and Cairns have published data on cloud-chamber tracks which they claim to be less ionizing than would be possible for singly charged particles, thus giving positive evidence for the existence of quarks of charge 2/3. They neglected the effects of the relativistic rise of ionization in the gas of their cloud chamber and it is believed they underestimated the errors of their drop count. Considering the fluxes of known particles in the cosmic rays it is concluded that their results can be explained as due to statistical fluctuations. (auth)

Weak

12929 (COO-1701-9) EXPERIMENTAL STUDY OF WEAK INTERACTIONS. Technical Progress Report. Winston, Roland (Chicago Univ., Ill. Enrico Fermi Inst.). Jan 1970. Contract AT(11-1)-1701. 7p. Dep. CFSTI.

A preliminary outline of research completed on lambda beta decays as a test of Cabibbo theory and time reversal invariance is presented. (C.E.S.)

12930 MEASUREMENT OF THE RATIO OF THE τ' PARTIAL DECAY RATES: $\Gamma(K^- \to \pi^-\pi^0\pi^0)/\Gamma(K^+ \to \pi^+\pi^0\pi^0)$. Herzo, D.; Banner, D.; Beier, E.; (and others). (Univ. of Illinois, Urbana). Phys. Rev.; 186: 1403-14(25 Oct 1969).

A scintillation-counter–optical-spark-chamber arrangement was used with incident 3.5-BeV/c positive and negative beams at the Argonne National Laboratory Zero-Gradient Synchrotron to study $\tau'(K^\pm \to \pi^\pm\pi^0\pi^0)$ decays. A difference between the τ'^- and τ'^+ partial decay rates would indicate the presence of a CP-violating $\Delta I \geq \frac{1}{2}$ amplitude in the weak Hamiltonian for these decays. Furthermore, in the absence of electromagnetic interactions, CPT invariance requires that $\Gamma(\tau^-) + \Gamma(\tau'^-) = \Gamma(\tau^+) + \Gamma(\tau'^+)$, where τ represents $K^\pm \to \pi^\pm\pi^+\pi^-$ decays. The result found after scanning the film and making small corrections for differences between the detection efficiencies for the two beam polarities was that $\Gamma(\tau'^-)/\Gamma(\tau'^+) = 1.011 \pm 0.018$. Also, by combining our result with the results of previous experiments on $K \to 3\pi$ decays, it was found that $[\Gamma(\tau^-) + \Gamma(\tau'^-)]/[\Gamma(\tau^+) + \Gamma(\tau'^+)] - 1 = 0.0029 \pm 0.0045$. (auth)

12931 DECAY PARAMETERS FOR $\Sigma^\pm \to n\pi^\pm$. Bangerter, Roger O.; Alston-Garnjost, Margaret; Barbaro-Galtieri, Angela; Gershwin, Lawrence K.; Mast, Terry S.; Murray, Joseph J.; Solmitz, Frank T.; Stevenson, M. Lynn; Tripp, Robert D. (Univ. of California, Berkeley). Phys. Rev.; 187: 1821-6(25 Nov 1969).

Measurements are presented of the decay parameters $\phi_\pm$ for $\Sigma^\pm \to n\pi^\pm$. The usual decay parameters α, β, and γ are related to ϕ by the equation $\beta = (1-\alpha^2)^{\frac{1}{2}}\sin\phi$ and $\gamma = (1-\alpha^2)^{\frac{1}{2}}\cos\phi$. Polarized $\Sigma^\pm$ were produced by the reactions $K^- p \to \Sigma^\pm\pi^\mp$ in the Lawrence Radiation Laboratory's 25-in. hydrogen bubble chamber. The average momentum of the incident K^- beam was 385 MeV/c. The measurements of $\phi_\pm$ were made by observing the left-right asymmetry in the np interactions of those decay neutrons that subsequently scattered on the hydrogen in the bubble chamber. $\phi_- = 14 \pm 19$ deg and $\phi_+ = 143 \pm 29$ deg were obtained. Since $\gamma = (|s|^2 - |p|^2)/(|s|^2 + |p|^2)$, this shows that $\Sigma^- \to n\pi^-$ takes place predominantly in the s wave, whereas $\Sigma^+ \to n\pi^+$ is dominated by p-wave decay. These results are in agreement with the $\Delta I = \frac{1}{2}$ rule. (auth)

Strong (Baryon-Induced)

Refer also to abstracts 13270 and 13331.

12932 (IS-T-330) TWO AND THREE PION PRODUCTION WITHOUT ANNIHILATION IN ANTIPROTON–PROTON INTERACTIONS AT 2.4 AND 2.9 GeV/c. Jespersen, Richard Allen (Ames Lab., Iowa). Nov 1969. Contract W-7405-eng-82. 68p. Dep. CFSTI.

Thesis.

From an analysis of 16,000 four-prong events in $\bar{p}p$ interactions at 2.4 GeV/c and 9400 at 2.9 GeV/c, final samples of 897 and 1015 events, respectively, were accepted as being due to the reaction $\bar{p}p \to \bar{p}p\pi^+\pi^-$. The cross section for this reaction is 1.48 ± 0.07 mb at 2.4 GeV/c and 2.53 ± 0.10 mb at 2.9 GeV/c. The data at both momenta are consistent with nearly 100% Δ^{++} Δ^{++} double resonance production, where Δ is the $p\pi$ resonance with $I = \frac{3}{2}$, $J^P = (3/2)^+$, central mass of 1236 MeV, and width of 120 MeV. No other resonances were seen. The reaction is peripheral at both momenta, the distribution of the center-of-mass scattering angle between the incoming $\bar{p}$ and the outgoing $\bar{p}\pi^-$ system being peaked at small angles. The $\rho_{1,1}$ spin-density matrix element has strong dependence Δ^2, the square of the four-momentum transferred from the incoming $\bar{p}$ to the outgoing $\bar{p}\pi^-$ system. The joint spin-density matrix elements indicate no correlation between the Δ^{++} and Δ^{++} production at either momentum. Calculations using the double-isobar one-pion-exchange model with form-factors were compared to the data. The prediction of the Δ^2 distribution is good at both momenta, while the $\bar{p}\pi^-$ and $p\pi^+$ invariant mass distributions have predicted peaks of the correct shape, but slightly too high in mass. The model reproduces the $\bar{p}\pi^+\pi^-$ and $p\pi^+\pi^-$ invariant mass distributions well at 2.9 GeV/c, but not at 2.4 GeV/c. The decay angular distributions are not correctly predicted, nor are the $\rho_{1,1}$ and $\frac{1}{2}(\rho^{3,3} - \rho^{1,1})$ spin-density matrix elements. The reactions $\bar{p}p \to \bar{p}p\pi^+\pi^-\pi^0$, $pn\pi^+\pi^+\pi^-$, and $\bar{n}p\pi^-\pi^-\pi^+$ were found to have cross-sections of 10 ± 5, 14 ± 10, and 17 ± 10 μb, respectively, at 2.4 GeV/c. The corresponding values at 2.9 GeV/c are 122 ± 40, 141 ± 70, and 125 ± 70 μb. (auth)

12933 (PURC-2137-17) AN EXPERIMENTAL TEST OF CHARGE INDEPENDENCE IN $n + p \to d + \pi^0$. Bartlett, D. F.; Friedberg, C. E.; Goulianos, K.; Hammerman, I. S. (Princeton Univ., N. J. Palmer Physical Lab.); Hutchinson, D. P. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). [1969]. Contracts AT(30-1)-2137; N0014-67-A-0151-0001. 45p. Dep. CFSTI.

The differential and total cross sections for the reaction $n + p \to d + \pi^0$ were measured for neutron kinetic energies between threshold (275 MeV) and 700 MeV. Results are presented based on 90,000 events. A comparison is made with existing data for $p + p \to d + \pi^+$ to test the prediction of charge independence, $d\sigma(np \to d\pi^0) = \frac{1}{2}\, d\sigma(pp \to d\pi^+)$ at the same cm energy and angle. No evidence for a violation is seen. Limits of a few percent are placed on the real part of certain amplitudes for I-spin nonconserving transitions from a study of the symmetry of the angle distributions about $\theta^* = 90°$. (auth)

12934 CHARACTERISTICS OF NONANNIHILATION INTERACTIONS OF 5 GeV/c ANTIPROTONS WITH EMULSION NUCLEI. Raghavan, I.; Kamal, A. A.; Padmavathi, S. V.; Rao, R.; Santhalakshimi (Osmania Univ., Hyderabad, India). Nuovo Cim.; 65A: 362-76(21 Jan 1970).

The energy and angular characteristics of surviving $\bar{p}$ at 5 GeV/c are presented. The mean inelasticity in the center-of-mass system for these events is found to be 0.45 ± 0.03. A smaller heavy-prong number of parent stars ($\langle N_h \rangle = 2.10 \pm 0.26$) indicates that the secondary $\bar{p}$ survive mainly from those collisions which take place on the nuclear periphery. The nonannihilation events are characterized by a smaller shower multiplicity ($\langle n_s \rangle = 1.65 \pm 0.06$) compared with the annihilation events ($\langle n_s \rangle = 4.50 \pm 0.74$). The mean emission angle of the surviving $\bar{p}$ is correlated, whilst its energy is anticorrelated with the shower multiplicity of parent stars. Then the mean transverse momentum of surviving $\bar{p}$ is found to be (334 ± 20) MeV/c. (auth)

12935 SPIN CORRELATIONS IN $\bar{p}p \to \bar{\Lambda}\Lambda$ AT 2.19 GeV/c. Kwak, N.; Mall, G. H.; Manweiler, J. E.; Nicholas, M. L.; Redeker, M. S.; Stringer, T. A.; Stump, R. (Univ. of Kansas, Lawrence). Phys. Rev.; 186: 1392-4(25 Oct 1969).

Large spin correlations between Λ and $\bar{\Lambda}$ hyperons were observed in the reaction $\bar{p}p \to \bar{\Lambda}\Lambda$, and they are very similar to the ones obtained by Badier et al. at 2.5 GeV/c. The correlation along the hyperon flight direction in the c.m. system is found to be -0.96 ± 0.44, which suggests that the hyperons are strongly in the spin triplet state. An analysis was made of the differential cross section and spin correlations in terms of the O(3,1) model. The result appears to be very encouraging. (auth)

12936 LIGHTLY IONIZING PARTICLES IN AIR-SHOWER CORES. Cairns, I.; McCusker, C. B. A.; Peak, L. S.; Woolcott, R. L. S. (Univ. of Sydney). Phys. Rev.; 186: 1394-1400(25 Oct 1969).

A search for quarks has been made in the cores of air showers of mean primary energy $\sim 4 \times 10^{15}$ eV. Four tracks whose specific ionization is about half that of a fast singly charged particle are described. Various mechanisms that might simulate a quarklike track are considered. The most probable of these is that of the separation of the ± ion columns in the clearing field, and evidence for and against this explanation is considered. If the particles are assumed to be quarks, a rough production rate can be deduced. This is compared with the limits set by earlier experiments. A decisive experiment to search for quarks of charge $\pm\frac{1}{3}$ e is proposed. (auth)

12937 NUCLEON–NUCLEON SCATTERING EXPERIMENTS IN THE RELATIVISTIC REGION AND POSSIBLE TESTS OF THE LONG-RANGE PION EXCHANGE. Thomas, Gerald Harper. Los Angeles; Univ. of California (1969). 139p.

Thesis.

The high-energy n-p charge exchange differential cross section exhibits a pronounced peak near the forward direction. Several models have been used in the attempt to describe this forward peak. Most of these models use pion exchange in some form. In particular, Byers has given a description of the forward peak using a long-range pion interaction. The possibility of testing the long-range pion interaction by means of polarization experiments is investigated. It is found that there are experiments which would test the presence of the long-range pion exchange. A measurement of $\bar{A}(t)$ in the region $0.01 \leq -t \leq 0.02$ would provide a definite test of the long-range pion exchange. A measurement of $P_0(t)$ in the region $0.01 \leq -t \leq 0.4$ might provide a test; it is possible that the long-range pion exchange does not contribute to $P_0(t)$. A measurement of D(t) in the region $0.01 \leq -t \leq 0.04$ might also provide a test of the long-range pion exchange. The tests found for $P_0(t)$, $\bar{A}(t)$, and D(t) are representative of tests which might be provided by other measurable quantities. The measured quantities were divided into four classes. Quantities in the same class provide similar tests for the long-range pion exchange. The quantities $P_0(t)$, $\bar{A}(t)$ and D(t) are probably the most easily measurable elements in three out of the four classes. The statements above about $P_0(t)$ and D(t) are somewhat indefinite because the model used has several unknown parameters. These parameters cannot be determined from the differential cross section; they must be determined from polarization measurements. It was studied how these droplet-model parameters may be determined from polarization measurements. In addition, a test was given for one of the important features of the droplet model; namely that the double-flip amplitude is large for $-t \gtrsim 0.25$. (Diss. Abstr.)

12938 LARGE-ANGLE p–d SCATTERING AT 580 MeV. Vincent, J. S. (Lewis Research Center, Cleveland); Roberts, W. K.; Boschitz, E. T.; Kisslinger, L. S.; Gotow, K.; Gugelot, P. C.; Perdrisat, C. F.; Swenson, L. W.; Priest, J. R. Phys. Rev. Lett.; 24: 236-9(2 Feb 1970).

The elastic scattering of protons from deuterons was measured at 580 MeV. The results for large-angle scattering are presented and discussed. The backward peak observed in the experiment is consistent with a baryon-exchange mechanism including the transfer of baryon resonances. (auth)

12939 ACCURATE PROTON–PROTON DIFFERENTIAL CROSS SECTIONS NEAR 10 MeV. Jarmie, Nelson; Brown, Ronald E.; Hutson, R. L.; Detch, J. L. Jr. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Lett.; 24: 240-2(2 Feb 1970).

In order to resolve inconsistencies in existing data, differential cross sections for the scattering of protons by protons were measured at 9.690 and 9.918 MeV with accuracies near 0.4% relative and 0.6% absolute. Sources of error are given and the data are compared with previous experiments and theory. (auth)

12940 DISCREPANCIES IN THE LOW-ENERGY PROTON–PROTON SCATTERING DATA. Holdeman, J. (Michigan State Univ., East Lansing); Signell, Peter; Sher, Michael. Phys. Rev. Lett.; 24: 243-5(2 Feb 1970).

A strong, disagreement for predictions near 10 MeV is found between two previous multienergy phase-shift analyses. The data also contain contradictions, but are found to definitely favor one of the antlyses over the other. Unresolved normalization discrepancies make further experimental work in the energy range 1 to 10 MeV mandatory. (auth)

12941 IDENTIFICATION OF A HIGHLY VARIABLE COMPONENT IN LOW-ENERGY COSMIC RAYS AT 1 A.U. Kinsey, James H. (Univ. of Maryland, College Park. Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev. Lett.; 24: 246-9 (2 Feb 1970).

Evidence is given for the existence of two distinct populations of cosmic-ray protons and alpha particles in the energy range of 4 to 80 MeV/nucleon: a highly variable component with an inverse energy dependence and a quasisteady "residual" component which shows a positive dependency on energy. The analysis is based on a series of four-day energy spectra obtained from the cosmic-ray experiments aboard IMP-IV during the time interval from 24 May 1967 to 20 August 1968. It is suggested that the highly variable component is probably entirely of solar origin. The "residual" component is most likely of galactic origin although below 10 MeV it may also contain some solar particles. (auth)

12942 REGGE CUTS, POMERANCHUK THEOREM, AND THE SERPUKHOV TOTAL-CROSS-SECTION DATA. Barger, V. (Univ. of Wisconsin, Madison); Phillips, R. J. N. Contract AT(11-1)-881. Phys. Rev. Lett.; 24: 291-3(9 Feb 1970).

A quantitative explanation is given, using Regge poles and cuts, for unexpected features of total cross sections in the newly accessible range 25 to 65 GeV/c. Negative contributions from the leading vacuum cuts explain the leveling out of $\sigma_T(K^-N)$ and $\sigma_T(\pi^-N)$ above 25 GeV/c; they also reconcile the apparently nonconverging $K^\pm N$ results with a common asymptotic limit, in accord with the Pomeranchuk theorem. (auth)

12943 DOES THE SLOPE OF THE HIGH-ENERGY ELASTIC PROTON–PROTON SCATTERING CROSS SECTION INCREASE AT SMALL MOMENTUM TRANSFER. Carrigan, R. A. Jr. (National Accelerator Lab., Batavia, Ill.). Phys. Rev. Lett.; 24: 168-71(26 Jan 1970).

Experimental information relating to the slope of the elastic proton-proton scattering cross section in the region of $-t = 0.15$ $(BeV/c)^2$ is reviewed. For proton energies greater than 18 GeV, most of the available data indicate that the slope changes from less than 9.0 $(BeV/c)^{-2}$ for $-t > 0.2$ $(BeV/c)^2$ to a value greater than 10.0 $(BeV/c)^{-2}$ for $-t < 0.15$ $(BeV/c)^2$. (auth)

12944 PROTON POLARIZATION IN $\Sigma^+ \to p\pi^0$. Harris, F. (Univ. of Michigan, Ann Arbor); Overseth, O. E.; Pondrom, L.; Dettmann, E. Phys. Rev. Lett.; 24: 165-8(26 Jan 1970).

The polarization of protons from the decay of polarized Σ^+ hyperons was measured by scattering the protons in a carbon-plate chamber. A sample of 1335 useful scatters gave $\alpha_0 = -0.98 \pm 0.05$ and $\varphi_0 = 22 \pm 90°$, where $\tan\varphi_0 = \beta_0/\gamma_0$. Using the data on $\Sigma^+ \to n\pi^+$ and $\Sigma^- \to n\pi^-$ and fitting to the $|\Delta I| = 1/2$ rule gave $\chi^2 = 0.3$ for 2 degrees of freedom. (auth)

12945 INELASTIC REACTIONS IN PROTON–DEUTERON SCATTERING AT 1.825 AND 2.11 GeV/c. Brunt, D. C.; Clayton, M. J.; Westwood, B. A. (Cavendish Lab., Cambridge, Eng.). Phys. Rev.; 187: 1856-67(25 Nov 1969).

The final states $p_sppp\pi^-$, $p_sppp\pi^0$, $p_spn\pi^+\pi^-$, and $n_sppp\pi^+\pi^-$ were observed in pd collisions at 1.825 and 2.11 GeV/c. The spectator-nucleon momentum and angular distributions are shown to require the addition of double-scattering events to the usual impulse-model predictions, in proportions varying between 15 and 40%. Results for the reaction $pn \to pp\pi^-$ are in good agreement with the one-pion-exchange model. The cross section for the T = 0 part of the reaction $pn \to pn\pi^+\pi^-$ rises by 0.92 ± 0.22 mb between 1.825 and 2.11 GeV/c, compared with a rise of 3 mb in the total T = 0 nucleon-nucleon cross section in the same energy region; but no evidence has been found for the reaction $pn \to NN^*(1470)$. (auth)

12946 SPIN ANALYSIS OF $p\pi^+\pi^-$ ENHANCEMENTS IN THE $pp\pi^+\pi^-$ FINAL STATE PRODUCED IN pp INTERACTIONS AT 22 GeV/c. Rhode, J. I.; Leacock, R. A.; Kernan, W. J.; Jespersen, R. A.; Schalk, T. L. (Ames Lab, Iowa). Phys. Rev.; 187: 1844-51(25 Nov 1969).

A study was made of decay angular distributions and other characteristics associated with enhancements near 1450 and 1700 MeV in the $p\pi^+\pi^-$ mass distribution for the $pp\pi^+\pi^-$ final state produced in pp interactions at 22 GeV/c. The results are consistent with a spin assignment of $1/2$ for the 1450-MeV effect if the $\Delta^{++}\pi^-$ branching of this effect is assumed to be small. This effect is associated with the $P_{11}(1470)$ state inferred from phase-shift analyses. In the case of the 1700-MeV feature, strong contributions from a $J = 5/2^+$ state are favored which can be reasonably associated with the $F_{15}(1690)$ state reported in the phase-shift work. (auth)

Strong (Meson-Induced)

12947 (INP–682, pp 48-90) ELASTIC SCATTERING OF HADRONS AT HIGH ENERGY. Czyzewski, O. (Institute of Nuclear Research, Krakow (Poland)).

A review of the elastic scattering of hadrons at high energies is presented. The diffraction peak, total cross sections, the Coulomb interference region, polarization, and the backward peak are considered. (J.F.P.)

12948 (INP–682, pp 168-204) DOUBLE PERIPHERAL MODEL IN REACTION $K^+p \to K^+\pi^-N^{*++}$ AT 5 GeV/c. Tuominiemi, J. (European Organization for Nuclear Research, Geneva (Switzerland)).

Some work done with available data on the reaction $K^+p \to K^+\pi^-N^{*2+}$ at 5 GeV/c to test some important aspects of the double peripheral model is reported. General properties of the double peripheral model are also outlined. (C.E.S.)

12949 REACTION $\pi^+n \rightarrow K^+K^-p$ AT 2.7 GeV/c. Garfinkel, A. F.; Lichtman, S.; Miller, R. J.; Willmann, R. B. (Purdue Univ., Lafayette, Ind.). Phys. Rev.; 186: 1400-2(25 Oct 1969).

A sample of 101 events of the reaction $\pi^+n \rightarrow K^+K^-p$ was isolated in a study of π^+d interactions at 2.7 GeV/c. A strong $Y_1^*(1520)$ signal is seen, but the K^+K^- spectrum shows no enhancements. The absence of a significant threshold enhancement in the K^+K^- system may be anomalous. (auth)

12950 PARTIAL-WAVE ANALYSIS OF $K^- + n \rightarrow \Lambda + \pi^-$ BETWEEN 1590 AND 1750 MeV. Mueller, Judith Ellen. Waltham, Mass.; Brandeis Univ. (1969). 75p.

Thesis.

A partial-wave analysis was performed on 2744 examples of the reaction $K^- + n \rightarrow \Lambda + \pi^-$ between 1590 and 1740 MeV cm energy. The data were obtained from a 100,000-picture exposure of K^- on deuterium in the Brookhaven National Laboratory 30'' bubble chamber at the AGS. The analysis assumed constant or resonant amplitudes, with no backgrounds to resonances. The analysis indicated a D3 ($\frac{3}{2}^-$) resonance at 1680 ± 10, $\Gamma = 73 \pm 30$, phase opposite the $Y_1^*(1765)$, $\sqrt{x_{\overline{K}N} x_{\Lambda\pi}} = .076 \pm .026$ where x is the branching ratio. (Diss. Abstr.)

12951 TWO- AND FOUR-CHARGED-PARTICLE FINAL STATES FROM THE INTERACTION OF 2.7-GeV/c π^+ ON DEUTERIUM. Miller, Robert Joseph. Lafayette, Ind.; Purdue Univ. (1969). 157p.

Thesis.

The final states having two and four nonstrange, charged particles and produced from the interaction of π^+ on deuterium at a π^+ laboratory momentum of 2.7 GeV/c were identified and investigated. The target-detector was the 72 inch bubble chamber at the Lawrence Radiation Laboratory at the University of California at Berkeley. Of primary interest was the production of meson resonances in these interactions. Evidence is presented for the existence of many such particles in these final states, including η, η', ω, ρ, f, A_1, and A_2. The baryon resonance $\Delta(1238)$ is also observed to be produced in a variety of reactions. Total and differential cross sections were determined for these processes. The reactions $\pi^+n \rightarrow \omega p$ and $\pi^+n \rightarrow \rho p$ were examined in some detail, including a determination of the spin density matrix elements for the ω and ρ. Also, the 3π system in the final state $pp\pi^+\pi^-\pi^0$ was studied at energies near the A_1 and A_2 masses in an attempt to separate these particles from the several other processes contributing to this final state. The results of a spin-parity analysis of the A mesons are presented. The spectator model of the π^+d interaction was examined and found to be a good approximation. This model not only gives a good description of the final state of the spectator nucleon, but is also supported by the similarity of such reactions as $\pi^+d \rightarrow pp\rho^0$ and $\pi^-p \rightarrow n\rho^0$. (Diss. Abstr.)

12952 SEARCH FOR AN I = ½ ISOBAR AT 1.9 GeV/c INCIDENT MOMENTUM IN THE REACTION $\pi^+p \rightarrow \pi^-N^{*+++}$. Banner, M.; Cheze, J. B.; Hamel, J. L.; Teiger, J.; Zaccone, H.; Zsembery, J. (CEN, Saclay, France). Nucl. Phys.; B15: 205-12(1970).

The π^- missing mass spectrum in the reaction $\pi^+p \rightarrow \pi^-N^{*3+}$ at 1.9 GeV/c for two emission angles of the π^- using a spark chamber spectrometer was obtained. In order to study the possible production of an I = ½ isobar, the contribution to the missing mass spectrum of the OPE model of Ferrari and Selleri was calculated. This gives an upper limit of the order of 40 μb for the production of such an isobar. (auth)

12953 ASYMMETRY AND DIFFERENTIAL CROSS SECTION FOR ELASTIC SCATTERING OF K^+ MESONS BY POLARIZED PROTONS AT 1.54 AND 1.71 GeV/c. Rebka, G. A. Jr.; Rothberg, J.; Etkin, A.; Glodis, P.; Greenberg, J.; Hughes, V. W.; Kondo, K.; Lu, D. C.; Mori, S.; Thompson, P. A. (Yale Univ., New Haven). Phys. Rev. Lett.; 24: 160-4(26 Jan 1970).

The asymmetry and differential cross section for elastic scattering of K^+ mesons from polarized protons were measured at meson momenta of 1.54 and 1.71 GeV/c, and these new data are included in an energy-independent phase-shift analysis. The $P_{\frac{1}{2}}$ wave obtained displays some resonancelike character. (auth)

12954 APPLICATION OF THE VENEZIANO MODEL IN THE REACTION $\pi^+d \rightarrow d\pi^+\pi^-\pi^+$ AT 5.4 GeV/c. Deery, B. J.; Mansfield, J. E.; Biswas, N. N.; Cason, N. M.; Kenney, V. P.; Poirier, J. A.; Shephard, W. D. (Univ. of Notre Dame, Ind.). Contract AT(11-1)-427. Phys. Lett.; 31B: 82-6(19 Jan 1970).

The Veneziano model for the spin-parity 1^+ case was applied to the low-mass 3π system produced in the reaction $\pi^+d \rightarrow d\pi^+\pi^+\pi^-$ and the results were compared with those for a symmetrized ρ-pole model. It was found that a nonzero $\epsilon^0\pi$ decay mode is needed to fit the Dalitz plot of the 3π system. The Veneziano model coherently incorporates the daughter ϵ^0 contribution along with the parent ρ trajectory in the amplitude and gives a good fit to the data with a value of $G_\epsilon/G_d = -0.15^{+.09}_{-.11}$ GeV^2, where G_ϵ and G_d are related to the s- and d-wave $A_1\rho\pi$ couplings. A symmetrized pole model can only be made to fit the data if both ρ and ϵ^0 pole contributions are assumed. (auth)

12955 PION–DEUTERON COHERENT SCATTERING AT HIGH-ENERGY. Bradamante, F.; Fidecaro, G.; Fidecaro, M.; Giorgi, M.; Palazzi, P.; Penzo, A.; Piemontese, L.; Sauli, F.; Schiavon, P.; Vascotto, A. (CERN, Trieste, Italy). Phys. Lett.; 31B: 87-92(19 Jan 1970).

The differential cross section for π^-d elastic scattering was measured at 9.0, 13.0, and 15.2 GeV/c for t-values up to 2.3 GeV^2. The results are analyzed by comparison with the Glauber scattering model. (auth)

12956 SEARCH FOR A Ap RESONANCE. Jain, P. L. (State Univ. of New York, Buffalo). Phys. Rev.; 187: 1816-20(25 Nov 1969).

The energy distribution of Λ's coming from K^- capture stars at rest was obtained measuring Λ's found by area scanning in photographic emulsion. This distribution is compared to a theoretical one obtained with an optical-model calculation. The conversion process $(\Sigma N) \rightarrow Ap$ plays an important part in the final state of Λ production. The results indicate that the conversion process is dominated by the (ΣN) triplet state and also that there is an enhancement in the Ap invariant-mass plot at about 2110 MeV with $\Gamma \simeq 20$ MeV. (auth)

12957 CHARGE EXCHANGE AND PRODUCTION OF η MESONS AND MULTIPLE NEUTRAL PIONS IN π^-p REACTIONS BETWEEN 654 AND 1247 MeV/c. Bulos, F. (Brown Univ., Providence); Lanou, R. E.; Pifer, A. E.; (and others). Contracts AT(30-1)-2098; AT(30-1)-2752; AT(30-1)-2262. Phys. Rev.; 187: 1827-44(25 Nov 1969).

An experiment designed to study the π^-p total neutral cross section and its breakdown into several channels was performed at eleven incident pion momenta ranging from 654 to 1247 MeV/c. Angular distributions for the charge exchange π^0 and for η^0 production are given in terms of Legendre-polynomial expansion coefficients. Forward and backward differential cross sections are presented for the charge-exchange channel and comparisons with recent dispersion-relation predictions for the forward cross section are made. (auth)

12958 ISOBAR PRODUCTION IN THE REACTION $\pi^- + n \rightarrow p + \pi^- + \pi^-$ AT 2.26 GeV/c. Benvenuti, Alberto (Univ. of Minnesota, Minneapolis); Marquit, Erwin; Oppenheimer, Frank. Phys. Rev.; 187: 1852-5(25 Nov 1969).

A baryon resonance of mass 1667 ± 5 MeV/c^2 is produced in the reaction $\pi^-d \rightarrow pp\pi^-\pi^-$ at 2.26 GeV/c in a non-t-channel process. Its properties and production mechanism are discussed. The branching ratio for its decay was found to be $\Delta\pi/N\pi < 0.11$. (auth)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstracts 13131 and 13198.

12959 PHASE REPRESENTATION FOR FORM FACTORS. Lusanna, L. (Univ., Florence). Nuovo Cim.; 65A: 511-20 (1 Feb 1970).

A new integral representation is obtained for the form factors in the elastic approximation, using the R method to introduce the inelasticity in the partial-wave scattering amplitude. This representation leads generally to a more convergent behavior at infinity than by the usual Goldberger-Treiman procedure. The NNπ form factor, with a nucleon off mass shell, is evaluated and it is used to get $g_A = 1.3$ from the Suura-Simmons sum rule. (auth)

12960 MULTIPARTICLE PHASE-SPACE IN TERMS OF INVARIANT MOMENTUM TRANSFERS, INVARIANT MASSES, AND ANGLES. Nyborg, P. (Agricultural Coll., Vollebekk, Norway). Nuovo Cim.; 65A: 544-77(1 Feb 1970).

Explicit expressions are derived for the $(3n-4)$-dimensional phase-space in terms of $n-1$ invariant momentum transfers, $n-2$ invariant masses, and $n-1$ angles (all angles defined in the laboratory frame) for $n = 3, 4, 5$ particle final states. Similar expressions are also given in terms of one invariant momentum transfer, $2n-4$ invariant masses, and $n-1$ angles (all angles defined in the rest frame of the two ingoing particles). Special attention is given to the boundaries of the physical regions and

to the various integrated forms that can be obtained analytically (Dalitz plots, triangular plots in invariant masses, Chew-Low plots, etc.). (auth)

12961 COHERENT SUPERPOSITION OF CHARGE STATES. Mirman, R. (Long Island Univ., Brooklyn). Phys. Rev.: 186: 1380-3(25 Oct 1969).

Some Gedankenexperimente are considered to illustrate the analogy between coherent superposition of angular momentum states and coherent superposition of charge states. (auth)

12962 HIGH ENERGY PHYSICS INDEX. VOLUME, NO. 25, 1969. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1969). 75p.

12963 HIGH ENERGY PHYSICS INDEX. VOLUME 7, NO. 24, 1969. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1969). 71p.

12964 FORM FACTORS WITH RISING PHASE. Yndurain, F. J. (CERN, Geneva). Nucl. Phys.; B15: 89-92(1970).

Form factors are investigated whose phase, $\delta(s)$ rises indefinitely (infinite number of resonances). If $\delta(s) \sim s$, all possible form factors are constructed with given phase. (auth)

12965 REDUCTIONS OF THE PHASE-SPACE INTEGRAL IN TERMS OF SIMPLER PROCESSES. Byckling, Eero; Kajantie, K. (Univ. of Helsinki). Phys. Rev.: 187: 2008-16(25 Nov 1969).

By using a $2 \rightarrow 3$-body reaction as a basic process, a recurrence relation is derived for the phase-space integral R_n of the reaction $p_a + p_b \rightarrow p_1 + \ldots + p_n$. By iteration, R_n can be written in the variables $s_i = (p_1 + \ldots + p_i)^2$, $t_i = (p_a - p_1 - \ldots - p_i)^2$, and $s_1 = (p_i + p_{i+1})^2$, $i = 1, \ldots, n-1$. The kinematical boundaries are stated explicitly, and the relation of this form to the form obtained from $1 \rightarrow 2$- and $2 \rightarrow 2$-body basic processes is clarified. This expression can also be applied to the Monte Carlo generation of events and to the summing of iterative production models by integral-equation techniques. The transformation of s_i to Toller angles is carried out, but the resulting expression is seen to be impractical at finite energies. Useful geometrical interpretations of Gram determinants of four-momentum vectors are given. (auth)

12966 EXISTENCE OF THE COVARIANT TIME-ORDERED PRODUCT OF CURRENTS. Dashen, R. F. (Inst. for Advanced Study, Princeton, N. J.); Lee, S. Y. Phys. Rev.: 187: 2017-26 (25 Nov 1969).

The existence of the covariant T product of any number of currents is investigated without introducing any extraneous assumptions. It is found that it does exist and can be constructed explicitly by an algebraic method. (auth)

12967 FINITE-COMPONENT WAVE EQUATIONS. Humi, Mayer (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev.: 187: 2278-9(25 Nov 1969).

Comments are made on the existence of finite-component equations which generate mass spectra. It is shown that a class of these equations satisfies the consistency test of Barut and Malin. (auth)

Electromagnetic

Refer also to abstracts 13023, 13024, 13134, 13140, 13158, and 13218.

12968 (NYO-3829-40) THE NONCOMPACT GROUP SU(2,2) AND ELECTROMAGNETIC FORM FACTORS OF BARYONS. Yao, Tsu (Pittsburgh Univ., Pa. Dept. of Physics). Oct 1969. Contract AT(30-1)-3829. 44p. Dep. CFSTI.

The noncompact group SU(2,2) and its unitary irreducible representations are used in the calculation of the electromagnetic form factors of baryons. The electromagnetic current is assumed to transform like the generators of the group. We find the following results: 1) for the discrete series $F_s(t) = [1 - (t/4M^2)]^{-n}$, $n = 3, 4, 5, \ldots$, 2) for the exceptional series $F_s(t) = [1 - (t/4M^2)]^{-2}$, 3a) for the principal series $p_0 = \frac{1}{2}$, $\rho > 0$ $F_s(t)$ is the sum of two hypergeometric functions and is oscillatory for large t, and 3b) for the most degenerate discrete series $F_s(t) = [1 - (t/4M^2)]^{-2}$. The principal series and the most degenerate discrete series are of particular interest since their "ground states" are precisely the same as those of the four-dimensional Dirac representation. This unitary analog of the Dirac representation suggests that we study reducible representations which are integral sums over ρ of UIR's in the principal series. Requiring that our form factor should be expressible in a closed analytic form puts severe restrictions on the weight function $A(\rho)$. A one-parameter formula which asymptotically behaves like t^{-4} and gives a satisfactory fit to the available experimental data to within 10-15% is found. (auth)

12969 NEAR EQUALITY OF THE ELECTRON AND NUCLEON ANOMALOUS MAGNETIC MOMENT. Strobel, G. L. (Univ. of Georgia, Athens). Nuovo Cim.; 65A: 421-2(1 Feb 1970).

It is pointed out that the observed anomalous magnetic moments of the electron, proton and neutron are approximately equal. (auth)

12970 SPIN-1 ELECTRODYNAMICS WITH AN ELECTRIC QUADRUPOLE MOMENT. Aronson, Harmon (Univ. of Chicago). Phys. Rev.: 186: 1434-41(25 Oct 1969).

The quantum theory of the electromagnetic interactions of a charged spin-1 particle is investigated within the framework of canonical field theory. An earlier treatment of this problem by Lee and Yang is generalized so as to include an arbitrary quadrupole moment. Some difficulties connected with the lack of relativistic covariance of the theory can be overcome without using Lee and Yang's "ξ-limiting formalism," provided one allows for direct scattering among the charged particles. (auth)

12971 REGGE TRAJECTORIES AND NUCLEON STRUCTURE. Frampton, P. H. (Univ. of Chicago). Phys. Rev.: 186: 1419-21(25 Oct 1969).

Assuming linearly rising Regge trajectories and neglecting the ϕNN coupling constant, a simple expression for the proton magnetic form factor $G_M^p(t)$ is considered which has poles at positive-integer values of the degenerate trajectory functions $\alpha_\rho(t)$ and $\alpha_\omega(t)$. (auth)

12972 PHOTOPRODUCTION OF VECTOR MESONS IN A REGGE-POLE MODEL. Gotsman, E.; Mannheim, P. D.; Maor, U. (Tel-Aviv Univ., Israel). Phys. Rev.: 186: 1703-12(25 Oct 1969).

A Regge-pole-model parametrization for the reaction $\gamma p \rightarrow V^0 p$ is constructed. Kinematical singularities and constraints are explicitly incorporated to minimize the number of independent residue functions. The residues for ρ, ω, and ϕ photoproduction are related to those in πN elastic scattering through various symmetry schemes and the vector-dominance model. A kinematic analysis of the vector-dominance model with relevance to our problem is presented. A detailed analysis of the experimental cross sections and polarization data for $\pi N \rightarrow \pi N$ and $\gamma p \rightarrow V^0 p$ is carried out. Ghost-eliminating mechanisms for the tensor trajectories are examined. A good fit to the over-all experimental data is obtained. It is shown that, given the πN scattering features, our model provides a parameter-free description of vector-meson photoproduction. (auth)

12973 VECTOR-MESON DOMINANCE AND HIGH-ENERGY ELECTROPRODUCTION OF THE ρ MESON. Cho, C. F.; Gounaris, G. J. (Univ. of Chicago). Phys. Rev.; 186: 1619-23(25 Oct 1969).

The vector-meson dominance (VMD) model is applied to the high-energy electroproduction of ρ mesons off unpolarized protons. It is shown that an experimental study of the angular distribution of the two pions produced from the decay of the final ρ can be used to measure directly the total ρp cross sections for transversely and longitudinally polarized ρ mesons. The ratio of these cross sections is important in the VMD theory of ep inelastic scattering. An expression for the differential cross section of the electroproduction of ρ mesons in the forward direction of the ρp scattering is also given in terms of these two cross sections. The q^2 dependence of the ρ-electroproduction amplitude is predicted, and certain checks of the model are also given. (auth)

12974 A TENTATIVE INTERPRETATION OF THE LONGITUDINAL TERM IN ELECTROPRODUCTION OF PIONS NEAR THE $M^*(1236)$ RESONANCE. Cochard, G.; Kessler, P. (College de France, Paris). Lett. Nuovo Cim.; 2: 783-5(1 Dec 1969).

An attempt is made to interpret the longitudinal cross section recently measured on inelastic electron scattering near the $\Delta(1236)$ resonance, by ascribing this cross section to the Born term alone, the N* term itself being supposed purely transverse. It is found that the Born terms may provide at least a qualitative explanation for the longitudinal term in electroproduction near the first N* resonance. (J.F.P.)

12975 THE PRINCIPLE OF ZERO, THE WEAK, AND ELECTROMAGNETIC MASS DIFFERENCES AND THE NEUTRAL CURRENT. Takasu, Masashi (Meijo Univ., Nagoya, Japan). Progr. Theor. Phys. (Kyoto); 42: 177-90(Nov 1969).

A unified treatment with the principle of zero (the cancellation of divergences) of quadratic and logarithmic divergences in the lowest-order mass differences between members of hadron unitary multiplet caused by weak bosons and photons is presented. It is shown that with charged currents alone, the diver-

gences cannot be cancelled, whereas with a neutral current added, which assures $|\Delta I| = \frac{1}{2}$, the cancellation occurs under rather natural choices of parameters, so that the above principle suggests one way to approach the divergence problems and the existence of a neutral current. (auth)

12976 VECTOR-DOMINANCE MODEL AND THE REACTION $\gamma p \to \pi^- \Delta^{++}$. Gotsman, E. (Univ. of California, San Diego, La Jolla). Phys. Rev.; 186: 1543-52(25 Oct 1969).

The vector-dominance-model (VDM) relation between the reactions (a) $\pi p \to \rho \Delta$ and (b) $\pi p \to \omega \Delta$ and the reaction (c) $\gamma p \to \pi \Delta$ is investigated within the context of the Regge-pole model. Parameters for the strong-interaction processes are determined by making a least-squares fit to the differential cross section and spin-density-matrix data. It is found that good agreement with the experimental measurements can be obtained by including the π, A_1, and A_2 trajectories for reaction (a), while for reaction (b) the exchange of the ρ and B trajectories is needed. Using values of the photon-vector-meson coupling constants, as determined from the leptonic decays of these mesons, and the VDM relations between the amplitudes for processes (a)–(c), the differential cross section for reaction (c) is calculated. This is found to be in good agreement with the experimental data and yields a $\chi^2 = 3$ for nine data. (auth)

12977 PION ELECTROMAGNETIC STRUCTURE FROM THE UNITARIZED VENEZIANO MODEL. Gensini, P. (Univ., Lecce, Italy. Istituto Nazionale di Fisica Nucleare, Bari, Italy). Lett. Nuovo Cim.; 2: 791-7(1 Dec 1969).

A previous proposal for unitarizing the Veneziano model by interpreting Veneziano partial waves as the K-matrix components is extended by linking the Veneziano model with the pion electromagnetic form factor. (J.F.P.)

12978 VENEZIANO-TYPE VERTEX FUNCTION AND PION ELECTROMAGNETIC FORM FACTOR. Namiki, Mikio; Ohba, Ichiro (Waseda Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 42: 1166-72(Nov 1969).

A possible method to formulate the Veneziano-type vertex functions is proposed with the help of a "spurion" having the vacuum quantum numbers. The method enables one to obtain the pion electromagnetic form factor consistent with experiment both for positive and negative t, and to predict $m_{\eta 0}^{+} = 1070$ MeV for the real scalar meson mass. (auth)

12979 COVARIANT EQUATIONS OF MOTION FOR A CHARGED PARTICLE WITH A MAGNETIC DIPOLE MOMENT. Suttorp, L. G.; De Groot, S. R. (Univ. of Amsterdam). Nuovo Cim.; 65A: 245-9(1 Jan 1970).

The Hamiltonian for a Dirac particle with anomalous magnetic moment in an electromagnetic field is transformed to even form up to terms linear in the coupling constant and without derivatives of the field. The even parts of the position and spin operators are derived by imposing conditions of covariance. Covariant equations of motion and of spin are then deduced; they turn out to have the same form as the classical equations for a composite particle with magnetic dipole moment. (The magnetodynamic effect for a particle in a time-dependent field is shown to contain the vector product of the electric field and the anomalous magnetic moment only.) (auth)

12980 LOW-ENERGY THEOREMS FOR e^4 COMPTON SCATTERING. Lin, K. Y. (Rockefeller Univ., New York). Nuovo Cim.; 65A: 188-96(1 Jan 1970).

The e^4 Compton scattering on targets with arbitrary spin was studied and the low-energy theorems of Cheng, Roy and Singh were generalized to higher order in photon energy ω. It is shown that the scattering amplitude has a term $\omega^3 \ln \omega$ whose coefficient is determined entirely by the charge and magnetic moment of the target. In order to derive the theorem, the Born contribution to the second-order (in ω) was evaluated explicitly in terms of the e^2 Compton scattering amplitudes. (auth)

12981 BROKEN-SYMMETRY SUM RULES AND $\rho\omega$ MIXING. Renard, F. M. (Department de Physique Mathematique, Montpellier, France). Nucl. Phys.; B15: 118-24(1970).

It is shown how broken SU(3) with U-spin invariance of the electromagnetic interactions, tadpole dominance for the $|\Delta I| = 1$ mass differences, and generalized Weinberg sum rules all agree in predicting a $\rho\omega$ mixing effect which is consistent with the experimental results $\Gamma_{\omega \to 2\pi} \approx 0.4$ MeV. (auth)

12982 CURRENT ALGEBRA, REGGE POLES, AND FORM FACTORS. Jengo, R.; Remiddi, E. (CERN, Geneva). Nucl. Phys.; B15: 1-16(1970).

The problem of the compatibility of current-algebra identities with the description of semi-weak scattering processes of currents on pions in terms of Regge poles or Veneziano models is investigated. Decomposing the scattering process into appropriate invariants and scalar amplitudes, it is shown that in the case of the commutator of axial currents it is possible to find a set of independent scalar amplitudes for which Regge poles in both channels or a Veneziano model can be assumed, and which determines the remaining amplitudes and the electromagnetic form factor. As a result, fixed poles appear where they are required, and the asymptotic behavior of the pion electromagnetic form factor is found to be of the form $t^{\alpha_\rho(s=m_\pi^2)-n}$, where $\alpha_\rho(s)$ is the trajectory exchanged in the channel of the incident current on the pion (i.e., the ρ-trajectory), s is the corresponding Mandelstam variable, m_π is the pion mass and n is an integer. The dependence of the sum rule on the invariant masses associated to the currents is also investigated, and the consistency of the approach is checked by considering also the commutator of two vector currents, which is found to give no new information on the form factor. (auth)

12983 TESTS OF VECTOR-DOMINANCE IN e^+e^- COLLISIONS ABOVE 1 GeV. Roy, Probir (Cornell Univ., Ithaca, N. Y.). Nucl. Phys.; B15: 35-44(1970).

Tests are proposed of various aspects of the vector-meson-dominance hypothesis that can be made by studying the reactions $e^+e^- \to \pi\pi$, $K\bar{K}$, $\pi\rho$, $\pi\omega$ and $\pi\phi$ above 1 GeV in the cm. (auth)

12984 PHOTOPRODUCTION OF NEUTRAL PIONS ON NUCLEI. Rej, A. K.; Prabhakar, N. D.; Ramachandran, G. (Indian Statistical Inst., Calcutta). Nucl. Phys.; B15: 56-60 (1970).

The photoproduction of neutral pions on ^{9}Be, ^{12}C and ^{16}O at 166 MeV is discussed using the impulse approximation and the theoretical amplitudes of Chew et al., Berends et al., and Schwela. The best χ^2 fits with experiments are obtained using oscillator wave functions and varying the nuclear radius as a parameter. This leads to the values R = 2.29 fm for ^{9}Be, R = 2.51 fm for ^{12}C and R = 2.26 fm for ^{16}O. (auth)

12985 INELASTIC AND FINITE-WIDTH EFFECTS FOR $e^+e^- \to 2\pi$, 3π, AND $K\bar{K}$. Renard, F. M. (Departement de Physique Mathematique, Montpellier, France). Nucl. Phys.; B15: 267-83(1970).

The Gounaris–Sakurai approximation is extended to the many channel case. In the case of the ρ meson propagator (in particular for the pion form factor) the finite width factor $a_\rho \equiv 1 + (\Gamma_\rho/m_\rho)d_\rho$ is substantially modified by the $K\bar{K}$ and mostly by the $\pi\omega$ closed channels; it is explicitly given in terms of the $f_{\rho K\bar{K}}$ and $f_{\rho\omega\pi}$ coupling constants. The ω propagator is essentially not modified by the width effects of the 3π and $K\bar{K}$ channels as Γ_ω is small. Important effects occur for the φ meson as this resonance is close to the K^+K^- and $K^0\bar{K}^0$ thresholds; the factor a_φ is decreased from 1.0 to 0.85 and the resonance shapes of the cross sections for $e^+e^- \to 3\pi$ and $K\bar{K}$ are deformed by an effect of 10%. (auth)

12986 DUALITY, QUARKS, AND INELASTIC ELECTRON–HADRON SCATTERING. Harari, Haim (Weizmann Inst. of Science, Rehovot, Israel. Rockefeller Univ., New York). Phys. Rev. Lett.; 24: 286-90(9 Feb 1970).

A model for high-energy hadron reactions is proposed, incorporating ideas borrowed from the duality scheme of strong interactions and from the quark version of the parton model for inelastic electron-hadron scattering. Experimental tests of the model are discussed. (auth)

12987 ELECTROMAGNETIC FORM FACTOR OF THE PION. Gerstein, Ira S.; Gottfried, Kurt; Huang, Kerson (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev. Lett.; 24: 294-6(9 Feb 1970).

A model for the pion electromagnetic form factor, based on duality and Regge asymptotic behavior for strong interactions is considered. It is found that $F_\pi(t) \xrightarrow{t \to \infty} t^{-\frac{1}{2}}$ and that vector dominance is expressed through second-order poles as t approaches the masses of vector mesons. (auth)

12988 PRODUCTION OF STRONGLY INTERACTING W's IN INELASTIC ELECTRON–NUCLEON COLLISIONS. Kogut, John B. (Stanford Univ., Calif.). Phys. Rev.; 186: 1540-3 (25 Oct 1969).

The possibility of extending the search for the intermediate vector boson by observing the products of inelastic electron-nucleon collisions is considered. If the W has a mass less than 5.1 BeV/c^2 and can interact strongly, then experiments at SLAC, which look for muons with large transverse momentum, should provide a sensitive test for its existence. If the W is not observed in the proposed experiments, then stringent upper bounds on the W-nucleon cross section can be deduced, or it can be concluded

that if a strongly interacting W exists, it must have a mass in excess of 5.1 BeV/c^2. (auth)

12989 VECTOR-MESON-DOMINANCE PREDICTIONS ON INELASTIC ELECTRON–PROTON SCATTERING. Cho, C. F.; Gounaris, G. J.; Sakurai, J. J. (Univ. of Chicago). Phys. Rev.; 186: 1734-7(25 Oct 1969).

Predictions of the (recently proposed) vector-meson-dominance model for inelastic electron-proton scattering are presented in a manner that can be compared directly with forthcoming experimental data. For large scattering angles ($\theta = 18° - 34°$), a spectacular variation is predicted in $d^2\sigma/d\Omega dE'$ as a function of the missing mass or q^2, in sharp contrast with the published 6° data, which exhibit a very weak q^2 dependence. νW_2 and $(q^2/\nu)W_1$ are also given as functions of ν/q^2. (auth)

12990 IMPACT FACTOR AND EXPONENTIATION IN HIGH-ENERGY SCATTERING PROCESSES. Cheng, Hung (Massachusetts Inst. of Tech, Cambridge); Wu, Tai Tsun. Phys. Rev.; 186: 1611-18(25 Oct 1969).

The exchange of an arbitrary number of photons between two fermions at high energies is considered, and an exponentiation, similar to that in the Glauber approximation and the droplet model, is obtained. When this result is applied to the processes of electron-electron scattering, Delbrück scattering, and photon-photon scattering, the scattering amplitude in each case can again be cast in the impact-factor representation. Although some modifications from the lowest-order result are necessary to account for the multiphoton effects, the impact factors themselves are not changed at all. The limitation of this exponentiation is discussed in connection with more complicated exchanges. (auth)

12991 CONNECTION OF ELASTIC ELECTROMAGNETIC NUCLEON FORM FACTORS AT LARGE Q^2 AND DEEP INELASTIC STRUCTURE FUNCTIONS NEAR THRESHOLD. Drell, Sidney D.; Yan, Tung-mow (Stanford Univ., Calif.). Phys. Rev. Lett.; 24: 181-6(26 Jan 1970).

It is suggested that if the structure function νW_2 for deep inelastic electron-proton scattering behaves near threshold as $\nu W_2 \sim (1/\omega)(1 - 1/\omega)^p$ for $\omega \equiv 2M\nu/Q^2 \to 1$, then the elastic electromagnetic form factor of the proton F_1 behaves for large momentum transfers as $F_1(Q^2) \sim (1/Q^2)^{(p+1)/2}$ for $Q^2 \to \infty$. (auth)

12992 CURRENT ALGEBRA IDENTITY IN THE σ-MODEL. Triantis, F. A. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Ann. Phys. (N. Y.); 56: 172-97(Jan 1970).

It is shown explicitly within the σ-model without nucleons and to any order in perturbation theory that the pion-vector current and the pion-axial vector current amplitudes satisfy the current algebra identity. The amplitude for pion production by an axial vector current satisfies a supplemented identity which includes terms arising from subtraction constants in the invariant amplitudes involved. The role of PCAC is investigated, and it is found that the generalized Ward identity is sufficient but not necessary for the current algebra identity to hold. (auth)

12993 ELECTROMAGNETIC MASS DIFFERENCES AND INELASTIC ELECTRON SCATTERING. Elitzur, Moshe; Harari, Haim (Weizmann Inst. of Science, Rehovot, Israel). Ann. Phys. (N. Y.); 56: 81-107(Jan 1970).

The Cottingham expression for the electromagnetic mass splitting within a given isomultiplet is studied with a particular emphasis on possible subtractions and divergences. Necessary and sufficient conditions for the convergence of the integration over the photon mass and for the validity of the contour rotation in the ν-plane are derived. The mass differences are expressed in terms of measurable inelastic electron scattering cross sections both in the subtracted and in the unsubtracted case. The subtraction function for $\Delta I = 1$ mass differences is expressed in terms of the A_2 residue function. The latter can be computed from the low energy data using finite energy sum rules, thus leading to a representation of ΔM in terms of low energy data alone. A naive application of this representation fails and the A_2-exchange alone is unable to yield the necessary correction for $\Delta I = 1$ mass differences. Possible reasons for this failure are discussed. (auth)

12994 NUCLEON POLARIZATION TRANSFER IN HIGH-ENERGY ELECTRON SCATTERING. Hey, A. J. G.; Kabir, P. K. (Oxford Univ. Rutherford High Energy Lab., Chilton, Eng.). Phys. Rev.; 187: 1990-2(25 Nov 1969).

The possibility is discussed of measuring cross terms between the form factors G_E and G_M through measurement of the transverse polarization of the recoil nucleon in the elastic scattering of high-energy electrons by polarized nucleons. (auth)

12995 PHOTOPRODUCTION AND THE ELECTROMAGNETIC MOMENTS OF CHARGED ρ MESONS. Clark, Robert Beck (Yale Univ., New Haven. Univ. of Texas, Austin). Phys. Rev.; 187: 1993-8(25 Nov 1969).

A gauge-invariant one-vector-meson-exchange (OVE) model is considered for the process $\gamma + n \to \rho^- + p$. The form of the model is determined by selecting the simplest extension of the OVE diagram consistent with gauge invariance. The model is used to calculate unpolarized differential cross sections between threshold and $E_{\gamma lab} = 3.0$ GeV for various values of the electromagnetic moments of the ρ^- meson. It is concluded from the results of the calculation that, if the experimental data were found to exhibit features of the OVE contribution near threshold, then information might be obtained from the process $\gamma + n \to \rho^- + p$ regarding the electromagnetic moments, and hence the internal structure of the charged ρ mesons. (auth)

12996 ASYMPTOTIC RELATIONS AMONG VECTOR AND AXIAL-VECTOR FORM FACTORS. Gordon, David (Southeastern Massachusetts Technological Inst., North Dartmouth. Massachusetts Inst. of Tech., Cambridge); Peccei, R. D. Contract AT(30-1)-2098. Phys. Rev.; 187: 1940-8(25 Nov 1969).

The constraints that current algebra and partial conversion of axial-vector current impose on the asymptotic behavior of axial-vector and vector form factors were investigated in the context of Fubini, Furlan, de Alfaro, and Rossetti's mass extrapolation formalism. First, relations for the nucleon-vector and axial-vector form factors as the four-momentum transfer $t \to -\infty$ were obtained in terms of electroproduction amplitudes of infinite photon mass. These unknown electroproduction amplitudes were subsequently eliminated by means of a link to a higher point function. In so doing, these unknown amplitudes can be expressed in terms of amplitudes whose behavior asymptotically is given by Regge theory, multiplied by known form factors. This approach has yielded the following relations among form factors, valid as $t \to -\infty$: $G_A(t) = G_A(0)G_M^V(t)$ and $G_E^V(t)/G_M^V(t) \to 0$. A critical discussion of the limit $t \to -\infty$ is also included. (auth)

12997 RADIATIVE CORRECTIONS TO AN ELECTRON–POSITRON SCATTERING EXPERIMENT. Hearn, Anthony C. (Stanford Univ., Calif.); Kuo, P. K.; Yennie, D. R. Contract AT(30-1)-2098. Phys. Rev.; 187: 1950-63(25 Nov 1969).

The radiative corrections for a precision experiment on electron-positron scattering performed by Browman, Grossetête, and Yount. It is necessary to extend the earlier work by Redhead and Polovin by evaluating the unobserved real bremsstrahlung without infrared approximations. To accomplish this efficiently and accurately, the very lengthy algebra is handled by a computer. Higher-order corrections are studied with care, and it is believed that our results are adequate for present and foreseeable experiments of this type. (auth)

12998 ELECTROMAGNETIC DECAYS OF PSEUDOSCALAR MESONS. Glashow, S. L.; Jackiw, R.; Shei, S. S. (Harvard Univ., Cambridge, Mass.). Phys. Rev.; 187: 1916-20(25 Nov 1969).

The electromagnetic 2γ decays of the neutral pseudoscalar mesons are discussed in the context of broken SU(3) × SU(3) and anomalous partial conservation of axial-vector current (PCAC). Particular attention is paid to the mixed ηX channel. It is predicted that the X width is enhanced beyond 80 keV. The observed value for the η width is used to compute $(F_K/F_\pi)^2 \approx 1.3$. (auth)

12999 CURRENT ALGEBRA, FIELD-CURRENT IDENTITY, THE $K_2^0K_1^0$ ELECTROMAGNETIC TRANSITION, AND THE DECAYS $K^0 \to \pi\pi e^+e^-$. Majumdar, D. P. (State Univ. of New York, Stony Brook. St. John's Univ., Jamaica, N. Y.); Smith, J. Phys. Rev.; 187: 2039-43(25 Nov 1969).

A general discussion is given of the matrix element for the decays $K^0 \to \pi\pi e^+e^-$; then, using the results of the vector-meson-dominance model to predict the $K_2^0K_1^0$ electromagnetic transition radius, partial conservation of the axial-vector current and current algebra to predict the $K_2^0 \to \pi^+\pi^-\gamma$ transition rate, and the experimental value of the CP-violating parameter ϵ, the following branching ratios are found: $\Gamma(K_2^0 \to \pi^+\pi^-e^+e^-)/\Gamma(K_2^0 \to \text{all}) = 1.7 \times 10^{-7}$, $\Gamma(K_1^0 \to \pi^0\pi^0e^+e^-)/\Gamma(K_2^0 \to \text{all}) = 0.2 \times 10^{-7}$, and $\Gamma(K_S^0 \to \pi^+\pi^-e^+e^-)/\Gamma(K_S^0 \to \text{all}) = 2.0 \times 10^{-5}$. (auth)

13000 TEST OF THE VALIDITY OF THE INFINITE-MOMENTUM LIMIT IN HIGH-ENERGY INELASTIC ELECTRON–PROTON SCATTERING. Lu, Eugene Y. C. (Ohio State Univ., Columbus). Phys. Rev.; 187: 2172-3(25 Nov 1969).

Assuming the validity of the $q_{\theta,3} \to \infty$ limiting procedure, it is shown that the deep inelastic electron-proton scattering cross section becomes purely longitudinal at $q^2 \to -\infty$ and $\omega \equiv -q^2/\nu$ fixed, while the transverse cross section falls off faster than $1/q^4$. (auth)

13001 THEORY OF DEEP-INELASTIC LEPTON–NUCLEON SCATTERING AND LEPTON-PAIR ANNIHILATION PROCESSES. I. **Drell, Sidney D.; Levy, Donald J.; Yan, Tung-mow (Stanford Univ., Calif.). Phys. Rev.: 187: 2159-71(25 Nov 1969).**

The structure functions for deep-inelastic lepton processes including (along with other hadron charges and SU_3 quantum numbers) $e^- + p \to e^- +$ "anything," $e^- + e^+ \to p +$ "anything," $\nu + p \to e^- +$ "anything," $\bar{\nu} + p \to e^+ +$ "anything" are studied in the Bjorken limit of asymptotically large momentum and energy transfers, q^2 and $M\nu$, with a finite ratio $w \equiv 2M\nu/q^2$. A "parton" model is derived from canonical field theory for all these processes. It follows from this result that all the structure functions depend only on w, as conjectured by Bjorken for the deep-inelastic scattering. To accomplish this derivation it is necessary to introduce a transverse momentum cutoff so that there exists an asymptotic region in which q^2 and $M\nu$ can be made larger than the transverse momenta of all the partons that are involved. Upon crossing to the e^+e^- annihilation channel and deriving a parton model for this process, the important result is obtained that the deep-inelastic annihilation cross section to a hadron plus "anything" is very large, varying with colliding e^-e^+ beam energy at fixed w in the same way as do point-lepton cross sections. General implications for colliding-ring experiments and ratios of annihilation to scattering cross sections and of neutrino to electron inelastic scattering cross sections are computed and presented. Finally, the origin of the transverse momentum cutoff and the compatibility of rapidly decreasing elastic electromagnetic form factors with the parton model constructed in this work are discussed. (auth)

13002 CALCULATION OF THE KAON ELECTROMAGNETIC MASS DIFFERENCE BASED ON THE VENEZIANO REPRESENTATION. **Scott, David M. (Ohio State Univ., Columbus). Contract AT(11-1)-1545. Phys. Rev.: 187: 2153-9(25 Nov 1969).**

An expression for the isovector part of the electromagnetic mass shift of the K mesons is derived from the difference of the first-order (in the fine-structure constant) electromagnetic self-energies of the positive and neutral kaons. Vector-meson dominance is used to relate this part of the mass shift to strong-interaction processes. A simplified Veneziano representation (including only one Regge trajectory in each channel) is written for these strong-interaction processes. The results are presented in terms of a cutoff on the four-momentum carried by the virtual photon producing the first-order mass shift. A relatively low cutoff value of about 3 BeV is required to yield the experimental mass difference. (auth)

13003 COMPTON SCATTERING AND REGGE CUTS. **Venturi, Giovanni (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev.: 187: 2147-52(25 Nov 1969).**

Multiple Pomeranchuk-trajectory exchange is studied in nucleon Compton scattering as an alternative means to a wrong-signature fixed pole in order to obtain a constant total asymptotic cross section and avoid paradoxes involving the vector-meson-dominance model. It is argued that the multi-Pomeranchon branch points interfere constructively, and an estimate is made of their contributions. It is found that the inclusion of up to five-Pomeranchon branch points leads to some 40% of the total nucleon Compton cross section. The implications of these results for the Pomeranchuk trajectory are discussed. (auth)

13004 TWO-PHOTON DECAYS OF π^0, η^0, AND $\eta'^0(958)$ IN BROKEN SU(3) SYMMETRY. **Matsuda, Seisaku (Polytechnic Inst. of Brooklyn); Oneda, S. Phys. Rev.; 187: 2107-10 (25 Nov 1969).**

By using the current algebra and the asymptotic SU(3) symmetry imposed only on the charge operator V_K, which is the SU(3) raising or lowering operator in the symmetry limit, two sum rules are obtained for the two-photon decay amplitudes of the π^0, η^0, and $\eta'^0(958)$. These sum rules, which are consistent with the Gell-Mann–Okubo mass splittings of the SU(3) multiplets, exhibit an interesting interplay between the physical masses, mixing and coupling constants. For example, in the first approximation, $R \equiv \langle\gamma\gamma|\eta^0\rangle/\langle\gamma\gamma|\pi^0\rangle = (1/\sqrt{3})(1/\cos\alpha)[(m_{\eta'}^2 - m_\pi^2)/(m_{\eta'}^2 - m_\eta^2)] \simeq (1/\sqrt{3}) \times 1.5$ is predicted in place of the SU(3) prediction $R = 1/\sqrt{3}$. Here α is the η-η' mixing angle. In an improved approximation, $R \simeq (1/\sqrt{3}) \times 1.7$ is obtained. The result indicates a significantly larger width for the $\eta^0 \to 2\gamma$ decay than the SU(3) value—a conclusion that is consistent with the present experimental observation. (auth)

13005 ASYMPTOTIC PROPERTIES OF VIRTUAL COMPTON AMPLITUDES IN THE LADDER MODEL. **Altarelli, Guido; Rubinstein, Hector R. (New York Univ., N. Y.). Phys. Rev.: 187: 2111-19(25 Nov 1969).**

The asymptotic properties of the virtual Compton scattering amplitude for a spacelike spin-1 photon off a scalar target, in the limit $k^2 \to \infty$, $\nu/k^2 = \rho$ fixed. This is accomplished by means of a perturbative model based on the ladder-diagram series. The absorptive parts of these amplitudes in the forward direction are related, as is well known, to the structure functions W_1 and W_2 that in turn describe inelastic electron scattering off the same target. In terms of W_1 and W_2 (using a ϕ^3 model for the hadron dynamics), we find that $W_1 \sim (1/k^2) \ln (k^2/m^2) F_1(\rho)$ and $W_2 \sim (1/k^2) F_2(\rho)$. Notice that in this model W_1 does not approach a constant limit. It is also found, for large ρ, that $F_1(\rho) \sim \lambda_1 \rho^{\alpha(0)}$ and $F_2(\rho) \sim \lambda_2 \rho^{\alpha(0)-2}$, where $\alpha(t)$ is the same Regge trajectory that dominates at high energy. To understand these results better, the Bjorken limit is studied for $ik_0 \to \infty$, both for spin-0 and spin-1 currents. In the first case, it is found that the expansion in inverse powers of ik_0 is valid for the first few terms, while in the second case, one of the invariant amplitudes shows a term $(ik_0)^{-2} \ln (ik_0)$. The similar behavior of W_1 for $k^2 \to \infty$ is presumably related to that logarithmic term. (auth)

13006 INELASTIC ELECTRON SCATTERING AND THE MULTI-REGGE MODEL. **Creutz, Michael J. (Stanford Univ., Calif.). Phys. Rev.; 187: 2093-6(25 Nov 1969).**

The multi-Regge model was investigated in the kinematic region where the four-momentum of one initial particle is large and spacelike. These kinematics occur in inelastic electron scattering through single virtual photon exchange. Contradicting present data, a rapid falloff is predicted in the cross section as the virtual particle becomes more spacelike. (auth)

13007 RADIATIVE CORRECTION TO THE GROUND-STATE ENERGY OF AN ELECTRON IN AN INTENSE MAGNETIC FIELD. **Jancovici, B. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Phys. Rev.: 187: 2275-6(25 Nov 1969).**

It is pointed out that the ground-state energy of an electron does not deviate much from mc^2, even in the presence of intense magnetic fields larger by several orders of magnitude than 10^{13} G. (auth)

13008 SIMULATION OF THE NUCLEAR-ELECTROMAGNETIC CASCADE DEVELOPMENT IN AN IONIZATION SPECTROMETER. **Jones, W. V. (Max-Planck-Institut fuer Physik und Astrophysik, Garching, Ger.). Phys. Rev.; 187: 1868-79 (25 Nov 1969).**

A simulation of the longitudinal nuclear-electromagnetic cascade development in an ionization spectrometer has been carried out using a Monte Carlo method. Details of the cascade model and the technique used for the calculations are presented. Calculations were performed to correspond to an actual spectrometer which was exposed to 10-, 20.5-, and 28-GeV/c incident protons at the Brookhaven Alternating Gradient Synchrotron (AGS). Particle-number distributions predicted by the calculations for different depths in the spectrometer are compared with the measurements. Results predicted by the calculations at higher energies extending up to 1000 GeV are also given. Means and standard deviations of the energy leaking out of the bottom of the spectrometer, as well as the energy dissipated in the form of nuclear disintegrations within the spectrometer, are tabulated for various depths for primary energies ranging between 10 and 1000 GeV. The energy leaking out of the sides of the spectrometer during the AGS measurements is estimated. The calculations show that the sum of particles recorded by the spectrometer increases linearly with energy for events undergoing the first interaction in the top layer of the spectrometer. (auth)

13009 DETERMINATION OF THE REAL PART OF THE COMPTON AMPLITUDE AT A NUCLEON RESONANCE. **Brodsky, Stanley J. (Stanford Univ., Calif.); Hearn, Anthony C.; Parsons, Ronald G. Phys. Rev.; 187: 1899-1904(25 Nov 1969).**

The real part of the virtual Compton amplitude can be directly determined from measurements of electron (or muon) bremsstrahlung or pair photoproduction. In general, the interference of the Compton amplitude with the Bethe–Heitler amplitude for pair production or bremsstrahlung yields a contribution to the cross section which is antisymmetric when the leptons are interchanged. This interference contribution thus produces different cross sections for electron and positron bremsstrahlung at a given scattering energy and angle. Also, the counting rate for pair production will depend on which lepton has the greater momentum. The determination of the real part of the Compton amplitude would supply information on the isobar resonance shape, test the dispersion relation for the forward amplitude, and resolve uncertainties in the determination of the nucleon resonances. A simple estimate for the lepton asymmetry of the pair production cross sections due to the forward Compton amplitude is given, in addition to a complete calculation of the effect of the first nucleon resonance using the isobar model. The results are also discussed for nuclear targets.

For the latter case, a broadening of the isobar decay width due to absorption in the nuclear medium must be taken into account. (auth)

13010 MODEL CONSTRUCTION OF THE NUCLEON ELECTROMAGNETIC-MASS-DIFFERENCE TADPOLE. Zee, A. (Harvard Univ., Cambridge, Mass.). Phys. Rev.; 187: 2227-30(25 Nov 1969).

Model expressions for the forward off-shell Compton scattering amplitudes with suitable high-energy behavior are given and used to compute the proton-neutron mass difference. (auth)

13011 INFLUENCE OF POLARIZATION EFFECTS ON CHARGE-CONJUGATION TESTS IN $\bar{p}p$ AND e^+e^- ANNIHILATIONS. Pais, A. (Rockefeller Univ., New York); Treiman, S. B. Phys. Rev.; 187: 2076-7(25 Nov 1969).

In general, the presence of initial-state polarization in e^+e^- or $\bar{p}p$ annihilation increases the possibilities of testing charge-conjugation invariance, as compared to the unpolarized case. These additional tests require polarization measurements. However, it remains possible to test C invariance even in the absence of initial-spin information, provided that one considers annihilations into four or more particles. These statements are free of any qualifications. For e^+e^- annihilations, they hold particularly in the presence of higher-order electromagnetic effects. (auth)

Weak

Refer also to abstracts 13001 and 13158.

13012 MODEL FOR HIGHER-ORDER WEAK INTERACTIONS. Li, L. F.; Segre, G. (Univ. of Pennsylvania, Philadelphia). Phys. Rev.; 186: 1477-83(25 Oct 1969).

The most divergent terms to all orders in G_F for $\Delta S = 0$ nonleptonic transitions are considered in a model of weak interactions. The analysis confirms and extends the conclusions of an earlier study of the model which showed that although terms of higher order in G_F diverged, they were compatible with a value of a cutoff Λ such that $G_F\Lambda^2 \sim 1$. (auth)

13013 SCHWINGER TERMS, FIELD ALGEBRA, THE PARITY-VIOLATING INTERNUCLEON POTENTIAL, AND MODELS OF THE WEAK HAMILTONIAN. Fischbach, E. (State Univ. of New York, Stony Brook); Tadic, D.; Trabert, K. Contract AT(30-1)-3668B. Phys. Rev.; 186: 1688-91(25 Oct 1969).

Using the current-field identity, it is shown that the entire vector-meson-exchange contribution to the parity-violating internucleon potential V_{12} derives from Schwinger terms arising from the commutator of the $\Delta S = 0$ F-spin currents and the weak Hamiltonian H_w. The vector-meson-exchange contributions are evaluated using field-algebra commutation relations and are shown to reproduce the generalized Michel potential. These results are used to express V_{12} as a function of an arbitrary model of H_w. (auth)

13014 DOUBLE-PION PRODUCTION BY HIGH-ENERGY NEUTRINOS. Bottino, A.; Ciocchetti, G. (Univ., Turin. Istituto Nazionale di Fisica Nucleare, Turin). Lett. Nuovo Cim.: 2: 780-2(1 Dec 1969).

An isobaric model is used for some preliminary calculations for double pion production in the reaction $\nu + n \rightarrow \mu^- + \pi^- + \pi^+ + p$ with N(1518) exchange. Total cross sections for energies from 1 to 8 GeV and differential cross sections for energies from 1 to 50 GeV are given. (J.F.P.)

13015 ON THE ADEMOLLO–GATTO THEOREM FOR AXIAL-VECTOR COUPLING CONSTANTS. Furui, S.; Trofimenkoff, N. N. (Australian National Univ., Canberra). Progr. Theor. Phys. (Kyoto); 42: 1214-15(Nov 1969).

A simple but approximate proof is given of the generalized Ademollo–Gatto theorem for baryon-beta-decay axial-vector coupling constants. The proof is based on a previously developed method of studying broken SU(3) symmetry. It is found that the observed baryon beta decay axial-vector coupling constants are not renormalized effectively to first order in the symmetry-breaking interaction. (J.F.P.)

13016 NONLEPTONIC HYPERON DECAYS AND STATIC SU(6) AS A REST CONDITION. Ishida, Shin (Nihon Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 42: 1173-6(Nov 1969).

It is shown that a new treatment of nonleptonic hyperon decays in SU(6) along the viewpoint proposed recently leads to a satisfactory understanding of the P-wave decays as well as the S-wave decays, deriving the Lee–Sugawara relation for both cases. (auth)

13017 A STUDY OF THE PRODUCTION AND PROPAGATION OF HIGH-ENERGY COSMIC-RAY MUONS. Cantrell, Wallace Gene. College Station, Tex.; Texas A and M Univ. (1969). 70p. Thesis.

A critical reexamination of the diffusion of cosmic rays in the atmosphere is made. The incorrectness of the use of λ_π, the pion attenuation mean-free-path, in the diffusion model is demonstrated. The muon intensity expected from the X process is calculated. The muon intensity data from the Utah neutrino detector are analyzed. The analysis indicated a higher percentage of X process production than that found by the Utah workers. The shortcomings of the analysis are pointed out. The consequences of an added component of the muon spectrum due to the X process on energy losses is examined. It is concluded that b_N must be at least five times as great as the theory indicates, and that if the proposed model is to obtain at higher energies an even more drastic modification will be necessary. (Diss. Abstr.)

13018 NONLEADING DIVERGENCES IN WEAK INTERACTIONS. Mohapatra, R. N.; Subba Rao, J. (Univ. of Rochester, N. Y.). Nuovo Cim.; 65A: 153-66(1 Jan 1970).

A study is made of the nonleading divergences in $\Delta Y = 1$ weak processes following a method used by Gatto et al., for the leading divergences. It is suggested that these divergences can cancel the divergences arising from the radiative corrections to the same processes. An explicit calculation to order g^4 and g^2e^2 of nonleptonic decay shows that, with suitable assumptions, the $\Lambda^2 \ln \Lambda$ divergences cancel for $g^2 \sim e^2/2$ (implying the rather high value $m_w \simeq 70$ GeV). (auth)

13019 CALCULATION OF THE μ–e RATIO FOR SEMILEPTONIC HYPERON DECAYS CONSIDERING q^2 DEPENDENT FORM FACTORS. Schroeder, U. E. (Univ., Frankfurt am Main). Nucl. Phys.; B15: 125-30(1970).

The calculation of the μ-e ratio for semi-leptonic baryon decays with change of strangeness is reported, taking into account the q^2 dependence of all form factors induced by regular currents. The calculated values are about 1 to 2% higher than those obtained by assuming constant form factors $F_1(0)$ and $G_1(0)$. It is found that if irregular currents were to be included the main contribution would come from the axial magnetism term g_2. (auth)

13020 SOFT-PHOTON THEOREMS AND RADIATIVE K_{l3} DECAYS. Fearing, Harold W.; Fischbach, Ephraim; Smith, Jack (State Univ. of New York, Stony Brook). Contract AT-(30-1)-3668B. Phys. Rev. Lett.; 24: 189-93(26 Jan 1970).

The soft-photon theorems of Low, Adler and Dothan, and Burnett and Kroll are applied to the radiative decays $K^- \rightarrow \pi^0 l^- \bar{\nu}\gamma$ and $\bar{K}^0 \rightarrow \pi^+ l^- \bar{\nu}\gamma$ (l = e or μ) to obtain the leading terms in the respective matrix elements. Numerical results for the photon spectra and for the decay rate (as a function of the minimum photon energy) are given in terms of the conventional K_{l3} parameters $f_+(0)$, ξ, λ_+, and λ_-. (auth)

13021 NEUTRON BETA DECAY IN A STRONG MAGNETIC FIELD. Fassio-Canuto, L. (Goddard Space Flight Center, New York). Phys. Rev.; 187: 2141-6(25 Nov 1969).

The β decay of a neutron in a strong quantizing magnetic field is studied by making use of the exact Dirac wave function for the electron in a magnetic field of arbitrary strength. The general conclusion is that the lifetime is unaffected by the magnetic field for $H < 10^{12}$ G. For $H > 10^{12}$ G, the lifetime in a vacuum is appreciably decreased. This conclusion is still valid when the decay takes place in a degenerate electron gas at densities lower than 10^6 g/cm^3. At higher densities, the lifetime in a magnetic field tends to reach the value in the absence of the field, for any field strength. (auth)

13022 ANALYSIS OF THE LEADING DIVERGENCES IN A MODEL OF WEAK INTERACTIONS. Appelquist, Thomas; Carlson, Carl-Edwin (Stanford Univ., Calif.). Phys. Rev.; 187: 2119-24(25 Nov 1969).

A model of the weak interaction is studied in which three W bosons interact with a triplet of fermion currents. The model is not renormalizable, but a canonical transformation of the Lagrangian is made that allows the most divergent terms in a perturbation series to be isolated, and their structure examined. Results recently obtained in lowest-order perturbation theory relating the leading divergence to the Cabibbo angle are explicitly shown to hold in all orders. (auth)

13023 η–π^0 MIXING, NONPOLE CORRECTIONS, AND THE PION-POLE MODEL OF $K_2^0 \rightarrow \gamma\gamma$ DECAY. Rockmore, Ronald (Imperial Coll. of Science and Tech., London). Phys. Rev.; 187: 2125-8(25 Nov 1969).

A brief review of the present experimental situation, after

Aubert, seems to indicate a value of 5×10^{-4} for the $K_1^0 \to \gamma\gamma$ branching ratio. Thus, although the pion-pole model (and its extension to σ-pole dominance of K_1^0 decays) makes predictions for the $K \to 3\pi$ and $\eta \to 3\pi$ decay spectra, and for the K_2^0-K_1^0 mass difference, which are in good agreement with experiment, no more than order-of-magnitude agreement can be claimed for the analogous calculation of the $K_1^0 \to \gamma\gamma$ branching ratio of 2.1×10^{-4} due to Arnowitt et al. It is assumed in this last calculation that $K_1^0 \to \gamma\gamma$ decay occurs via the naive mechanism $K_1^0 \to$ (off-shell) $\pi^0 \to \gamma\gamma$, and an SU(3)-symmetric model of PVV couplings which gives good results for both $\pi^0 \to \gamma\gamma$ and $\eta \to \gamma\gamma$ decays is used for the $\pi^0\gamma\gamma$ vertex. It is shown here that rather sizable corrections to the naive pole model for $K_1^0 \to \gamma\gamma$ decay may easily account for the large discrepancy between theory and experiment in this case. In particular, the η-pole contribution from η-π^0 mixing calculated in the same physical model of PVV couplings yields a correction of 19% to the naive amplitude (but of indeterminate sign). (On the other hand, in the case of $\pi^0 \to \gamma\gamma$ decay, the η-pole contribution is only about 4% of the usual amplitude in magnitude, and has merely the effect of enlarging somewhat the domain of acceptable values of the parameters characterizing the same model of PVV couplings.) The PVV-PVV and PPV-PPV nonpole corrections are next investigated in perturbation theory; these corrections are also found to be quite sizable; but, owing to sign indeterminacy, neglect of damping, etc., these calculations are only of qualitative interest. It is concluded that the calculation of the $K_1^0 \to \gamma\gamma$ branching ratio is not likely to be a very sharp test of the pole model. (auth)

13024 ELECTROMAGNETIC EFFECTS AND K_L DECAYS. Christillin, P. (Scuola Normale Superiore, Pisa, Italy). Phys. Rev.; 187: 1912-15(25 Nov 1969).

The non-Hermiticity of the T matrix because of the possible interference between electromagnetic and weak Hamiltonians in K_L decays is analyzed. It is shown that even if H_{em} has a large CP-violating part, the corrections to the standard K phenomenology are depressed by reason of phase-space considerations and therefore the usual formulas are justified. (auth)

13025 UNIVERSALITY OF WEAK CORRECTIONS TO β DECAY. de Alwis, S. P.; Nutbrown, D. A. (Cambridge Univ., Eng.). Phys. Rev.; 187: 2257-9(25 Nov 1969).

The quadratically divergent weak corrections to β decay separate into two parts. One is proportional to the zeroth-order matrix element, and is universal, and the other which involves a current-divergence commutator just contributes a mass-renormalization term for the lepton case (μ decay) but is not easily interpretable as such for the case of the hadrons. This latter term is calculated in a specific model and contributions are found which explicitly violate universality. This trouble is, however, not present in the new theory of weak interactions proposed by Gell-Mann et al. (auth)

13026 ENERGY DEPENDENCE OF PION ASYMMETRY IN THE RADIATIVE DECAY OF POLARIZED Σ. Chan, L. H.; Ebrahim, A.; Socolow, R. H. (Yale Univ., New Haven). Contract AT(30-1)-2726. Phys. Rev.; 187: 2266-9(25 Nov 1969).

The energy dependence of pion asymmetry relative to the direction of Σ polarization in the decay $\Sigma \to n\pi\gamma$ is calculated, using the inner-bremsstrahlung model. It is found that the kinematic enhancement of the pion asymmetry is large only for $\Sigma^- \to n\pi^-\gamma$, and only in the region of low pion energy, which is not yet experimentally accessible. (auth)

Strong (General)

Refer also to abstracts 12942 and 13158.

13027 (INP-682) PROCEEDINGS OF THE IX CRACOW SCHOOL OF THEORETICAL PHYSICS. Volume II. (Institute of Nuclear Physics, Krakow (Poland)). Jun 1969. 222p. Dep. CFSTI (U. S. Sales Only).

Separate abstracts are prepared for the 8 lectures included. (C.E.S.)

For abstracts of individual lectures see: 12947, 12948, 13028–13030, 13081, 13116, and 13117.

13028 (INP-682, pp 91-137) OVERLAP FUNCTION CALCULATION IN STRONG INTERACTIONS. Stroynowski, Ryszard (Warsaw Univ. (Poland). Inst. of Experimental Physics).

The relation between elastic scattering and inelastic collisions of hadrons in the high-energy region is discussed. It is shown what information about inelastic scattering can be obtained from elastic scattering, and the testing of various models for inelastic processes using elastic scattering data is described. The unitarity equation, overlap function formalism for the spinless case, properties of overlap functions, unitarity equation for partial waves and shadow elastic scattering, and overlap function formalism for the spin (0, ½) case, are discussed. Scattering amplitudes, the determination of the overlap function for inelastic $\pi^+ + p$ collisions, attempts to determine the overlap function directly from the inelastic processes and their models, and the overlap function for two-body inelastic processes are also considered. (J.F.P.)

13029 (INP-682, pp 156-67) DOLEN-HORN-SCHMID DUALITY. Kotanski, A. (Jagellonian Univ., Krakow (Poland). Inst. of Physics).

Duality is defined, and some of the ideas that gave rise to the concept of duality are outlined. Problems that have arisen in duality theory are considered. Duality diagrams are discussed and are illustrated for some specific examples. (C.E.S.)

13030 (INP-682, pp 205-17) QUARK MODEL (COLLISIONS). Zalewski, K. (Institute of Nuclear Research, Krakow (Poland)).

Two-body small-angle scattering in the quark model is discussed with emphasis on recent results. The discussion is not necessarily limited to the region of the diffraction peak. The particles considered are the mesons from the pseudoscalar and vector nonets and baryons and antibaryons from the $\frac{1}{2}^+$ octet and $\frac{3}{2}^+$ decouplet. (C.E.S.)

13031 REGULARIZATION AND WARD-IDENTITY ANOMALIES. Brown, R. W.; Shih, Chia-chang; Young, Bing-lin (Brookhaven National Lab., Upton, N. Y.). Phys. Rev.; 186: 1491-1504(25 Oct 1969).

In the content of the free-quark model, the validity of the naïve Ward identities (WI's) is discussed for arbitrary regularized n-point functions of scalar, pseudoscalar, vector, and axial-vector currents. In a simple version of the regularization procedure described by Pauli and Villars, it is found that the naïve vector WI's are all automatically satisfied, and that there is a compact necessary condition for the existence of the axial-vector anomaly. Subsequently, this version leads to a large number of anomalous axial-vector WI's (corresponding to the cases n = 2, 3, 4, and 5). It is shown that this number cannot be reduced, for example, to Bardeen's "minimal" solution without additional counterterms beyond those possible in the general regularization framework—in spite of the framework's well-known ambiguities. Other minimal sets are discussed, as well as a symmetry-breaking model in which no further anomalies are found. The explicit forms of the WI anomalies for the general minimal solution are given along with the necessary counterterms. (auth)

13032 QUARK MODEL AND THE POMERANCHUK THEOREM. Tomozawa, Yukio (Univ. of Michigan, Ann Arbor). Phys. Rev.; 186: 1504-9(25 Oct 1969).

It has been pointed out that the quark model may not be compatible with the Pomeranchuk theorem. One such model is investigated in more detail, and the implications of violation of the Pomeranchuk theorem, if any, are discussed. (auth)

13033 NONRELATIVISTIC STRONG-COUPLING MODEL WITH A RECOILING SOURCE. Krass, Allan S. (Univ. of California, Santa Barbara). Phys. Rev.; 186: 1713-25(25 Oct 1969).

The static extended source of traditional strong-coupling models is replaced with a point fermion of finite bare mass. Self-consistent stationary-state solutions to the problem of the strongly coupled fermion and pion field are found in the neutral pseudoscalar theory. The usual set of rotational levels, $j = \frac{1}{2}, \frac{3}{2}, \frac{5}{2}, \ldots$, and, in addition, a class of states which strongly suggest identification with the $N'(1470)$ and its possible rotational excitations are found. The model provides a natural interpretation of the repulsive hard-core potential in nuclear forces, and also contains the mechanisms which will lead to negative-parity nucleon resonances and Regge recurrences when internal symmetries are included. Because of several important approximations, our numerical results are not yet to be taken seriously. (auth)

13034 SOFT-CORE POTENTIAL MODEL FOR NUCLEON–NUCLEON SCATTERING. II. Sprung, Donald W. L.; Srivastava, M. K. (McMaster Univ., Hamilton, Ont.). Nucl. Phys.; A139: 605-24(1969).

A number of local potentials which provide good fits to the $^1S_0$ phase shifts of MacGregor, Arndt, and Wright for pp and np scattering are described. Their relation to Bargmann potentials is exhibited. The off-energy-shell properties of these potentials are studied in relation to a number of well-known potentials. The implications of the existence of soft local potentials for several nuclear problems are discussed. (auth)

13035 MASS FORMULAS FROM THE ALGEBRA OF CURRENT DIVERGENCES. Ryder, L. H. (Univ. of Kent, Canterbury, Eng.). Lett. Nuovo Cim.; 2: 765-70(1 Dec 1969).

The consequences of the algebra of current divergences are presented more completely in terms of the mass formulas implied by it. Only particular commutators of currents with time derivatives of currents are used, and operators are always chosen which commute. The mass formulas are given for the lowest-lying multiplets obtainable from vector-meson and vector-axial vector operators. (J.F.P.)

13036 QUARKS WITH COMPLEX SPIN. Roginskii, V. I.; Shapiro, I. S. JETP Lett. (USSR) (Engl. Transl.); 10: 172-4 (20 Sep 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu: 10: 270-3(20 Sep 1969).

It is shown that it is possible to construct a quantum dynamics of a system consisting of two quarks with complex spins namely, by introducing a Hilbert space of states and a Hamiltonian, and by taking into account the identity of the quarks. The composite model in which quarks are ascribed a complex spin is equivalent to a certain parametrization, in a definite group-theoretical sense, of the internal state of the particles. (L.B.S.)

13037 RELATIVISTIC EXTENSION OF THE Le COUTEUR–NEWTON FORMALISM. II. OVERLAPPING THRESHOLD CASE. Benayoun, M.; Leruste, Ph. (College de France, Paris). Nuovo Cim.; 65A: 99-116(1 Jan 1970).

In this work, a relativistic extension of the determinantal formalism is continued. It is proved in the overlapping threshold case, that the single many-valued meromorphic function D defined on a 2^n-sheeted Riemann surface, becomes a set of 2^{n-1} meromorphic functions defined on a two-sheeted Riemann surface. Assuming the B/B formalism for the many-channel K-matrix, it is proved that the many-channel S-matrix can be still described through a D/D formalism, even when the thresholds are overlapping. The splitting of masses effects and the way to get continuously from the overlapping threshold case to the split-out threshold case, when this is meaningful, are examined. Finally the formalism is applied to problems concerning spin, isospin and SU_2-symmetry breaking. (auth)

13038 GROUP-THEORETICAL APPROACH TO THE MULTIPERIPHERAL MODEL. Ferrara, S. (CNEN, Frascati, Italy); Mattioli, G. Nuovo Cim.; 65A: 25-54(1 Jan 1970).

The convergence of the multiperipheral series is investigated in the case of the scattering of two spinless particles, when the square of the spacelike momentum transfer W is fixed as a parameter. A "coupling scheme" is introduced in which the scattering amplitude is described as a pseudobilinear functional on some Hilbert spaces which contain elements describing an incoming and outgoing particle. So in this formalism to every multiperipheral graph is associated a pseudobilinear functional. The properties of the series are studied by means of the "crossed" partial-wave analysis. Using Fredholm techniques and analyticity properties it is shown that the graph series sum, in correspondence to physical values of the coupling constant g, is described by an unbounded functional which cannot be expressed only by means of the unitary irreducible representations of the principal series of $O_{2,1}$. In this formalism this means that the amplitude contains some Regge-pole contributions. The Regge asymptotic behavior of the solution and a new formulation of the Froissart bound are pointed out. The usefulness of the method for the ladder-approximation case is then discussed. (auth)

13039 SCATTERING AND PRODUCTION OF EXCITED HADRONS. Arnold, Richard C. (Argonne National Lab., Ill.); Freund, P. G. O. Phys. Rev.; 186: 1631-4(25 Oct 1969).

Models for heavy meson and baryon states contain consequences for their high-energy scattering on other particles. Features of production reactions are discussed which depend on these scattering properties, and specific proposals are made for experiments. (auth)

13040 THREE-DIMENSIONAL COVARIANT INTEGRAL EQUATIONS FOR LOW-ENERGY SYSTEMS. Gross, Franz (Cornell Univ., Ithaca, N. Y.). Phys. Rev.; 186: 1448-62(25 Oct 1969).

Integral equations suitable for the dynamical treatment of strongly interacting particles are derived. The equations can be described as Bethe–Salpeter equations with one particle restricted to the mass shell, resulting in a three-dimensional covariant equation which can be easily interpreted physically. To restore the dynamical terms omitted in the process of restricting one particle to the mass shell, additional kernels are added to the irreducible kernels from the original Bethe–Salpeter equation. The addition of these extra terms leads to a resulting simplification in the kernels themselves, since the new kernels have the same structure as the original ones, with some partial cancellations. Estimates as to the convergence of the procedure and the sizes of the various potentials are given. The special case of the hydrogen atom is discussed briefly, and comments are made on the application of these equations to the nuclear-force problem. Connections between scattering equations and bound-state equations are discussed, and the relativistic normalization condition for bound-state wave functions is derived. (auth)

13041 PARTIAL WIDTHS OF EXCHANGE-DEGENERATE PARTNERS. Capps, Richard H. (Purdue Univ., Lafayette, Ind.). Phys. Rev.; 186: 1514-16(25 Oct 1969).

The ratios of partial widths (or coupling constants) of baryons and mesons on exchange-degenerate Regge trajectories are computed and compared with experiment. The Veneziano representation is used as a guide to the energy dependence of residue functions. Particular attention is paid to $\pi\Sigma$ and $\pi\Xi$ states. In most cases for which the partial-width data are fairly accurate, the agreement with experiment is excellent. (auth)

13042 DUALITY AND MULTIPERIPHERAL PROCESSES. Dremin, I. M.; Royzen, I. I. (Lebedev Inst. of Physics, Moscow). Phys. Lett.; 31B: 71-4(19 Jan 1970).

The combined use of the finite energy sum rules approach for the treatment of cross sections in the resonance region and of the Bethe–Salpeter equation for the description of inelastic processes at high energies leads to a relation between the leading Regge trajectory and other trajectories. An upper limit of the resonance region appears in equations as a parameter, which, within the framework of the Bethe–Salpeter equation, was previously shown to be of the order of a fireball mass. An estimate of its value (with Regge trajectories assumed to be known) shows that it coincides with values given both by finite energy sum rules and by cosmic ray experiments. (auth)

13043 MULTIPERIPHERAL MODEL SUGGESTION OF A DAMPED OSCILLATORY COMPONENT IN HIGH ENERGY TOTAL CROSS SECTIONS. Chew, G. F.; Snider, D. R. (Univ. of California, Berkeley). Phys. Lett.; 31B: 75-8(19 Jan 1970).

A simplified multiperipheral model is used to illustrate the possibility of complex Regge poles that contribute damped oscillations to the total cross section. The model suggests a relation between the period of the oscillations and the rate of growth of average multiplicity with energy. (auth)

13044 QUARK SELECTION PRINCIPLE. Schiff, L. I. (Stanford Univ., Calif. Imperial Coll. of Science and Tech., London). Phys. Lett.; 31B: 79-81(19 Jan 1970).

A selection principle that permits only the observed combinations of quarks to exist as well-separated clusters is formulated in terms of a boundary condition on the many-particle wave function. Calculated quantities are in reasonable agreement with experiment. (auth)

13045 RELATIVISTIC HADRON MODEL WITH INTRINSIC MASS SPLITTINGS. Gupta, Suraj N. (Wayne State Univ., Detroit). Phys. Rev.; 187: 1984-90(25 Nov 1969).

A simple mechanism for the SU(3)-symmetry breaking in strong interactions is introduced by using the formalism of the multispinor field equations, which avoids the use of physical quarks but has resemblance to the quark model. The resulting treatment leads to Gell-Mann–Okubo mass formula for baryons, but not for mesons. It yields approximate values of $-19.5°$ and $33°$ for the η-η' and ϕ-ω, mixing angles, respectively, and also provides a reasonable explanation for the intermultiplet meson mass formula $m_K^2 - m_\pi^2 = m_K^2 - m_\rho^2$. (auth)

13046 FACTORIZATION OF CROSS SECTIONS AND THE MULTIPERIPHERAL MODEL. Yesian, H. J. (Univ. of California, San Diego, La Jolla). Phys. Rev.; 187: 2279(25 Nov 1969).

Under certain conditions, the multiperipheral model predicts that elastic and inelastic parts of total cross sections factorize independently. Together with the evidence for a universal hadronic opacity, σ_{el}/σ_T, it implies the factorization of total cross sections. (auth)

Strong (Baryon No. = 0)

Refer also to abstracts 13113, 13203, and 13206.

13047 FURTHER CONSTRAINTS ON THE PION–PION PARTIAL-WAVE AMPLITUDES. Cheung, F. F. K. (Univ. of Notre Dame, Ind.); Chen-Cheung, F. S. Nuovo Cim; 65A: 347-61(21 Jan 1970).

A number of new constraint relations are obtained for the partial-wave amplitudes of pion-pion scattering. (auth)

13048 CROSSING RESTRICTIONS ON $\pi\pi$ PARTIAL WAVES. Roskies, R. (CERN, Geneva). Contract AT(30-1)-2726. Nuovo Cim.; 65A: 467-90(1 Feb. 1970).

A parametrization is found for the most general $\pi\pi$ partial-wave amplitudes consistent with crossing symmetry and isospin invariance. All the constraints on the partial-wave amplitudes are written, which follow from, and which ensure, crossing symmetry. It is then discussed how these relations might be useful. In particular, application is made to Brown and Goble's model for $\pi\pi$ scattering. (auth)

13049 EXPERIMENTAL IMPLICATIONS OF THE BARDAKCI–RUEGG REPRESENTATIONS FOR RESONANCE PRODUCTION. Gunion, John F.; Yesian, H. J. (Univ. of California, San Diego, La Jolla). Phys. Rev.; 186: 1415-19(25 Oct 1969).

The experimental implications of the Bardakci–Ruegg representation for the five-particle processes $K\bar{K}\pi\pi\pi$ and $KKK\bar{K}\pi$ are investigated in the region of various resonance productions. As in the Veneziano representations, there are many spins present in high-mass resonances. The angular momentum content of the resonances and the angular distributions of the decay products are studied as a function of momentum transfer. In a number of cases, it is found that there is only a very small admixture of odd daughters. In these instances, the condition under which the odd daughters vanish is nearly equivalent to certain previously obtained mass formulas. (auth)

13050 UNIQUE SET OF I = 0 S-WAVE $\pi\pi$ PHASE SHIFTS. Scharenguivel, J. H. (Pardue Univ., Lafayette, Ind.); Gutay, L. J.; Miller, D. H.; (and others). Phys. Rev.; 186: 1387-91 (25 Oct 1969).

It was found that the forward-backward asymmetry exhibits a very slight Δ^2 dependence affording a model-independent extrapolation. When the above method is complemented with a factorization-model analysis, a unique set of I = 0 S-wave pion-pion phase shifts is obtained, modulo π. New tests of the absorption model are made. (auth)

13051 PION LIFETIME, $\rho\pi$ AND $\sigma\pi$ INTERMEDIATE STATES, AND SUM RULES. Coleman, R. A.; Moffat, J. W. (Univ. of Toronto). Phys. Rev.; 186: 1635-42(25 Oct 1969).

The pion lifetime is calculated assuming an unsubtracted relation for the axial-vector matrix element and using $\rho\pi$ and $\sigma\pi$ intermediate states as well as the $\bar{N}N$ intermediate state. By imposing convergence conditions, a series of sum rules is obtained, including the generalized Kawarabayashi–Suzuki–Riazuddin–Fayyazuddin relation and modified Goldberger–Treiman relations. By assuming that the $NN\pi$, $\rho\pi\pi$, and $\sigma\pi\pi$ vertex functions are dominated by a three-pion resonance with I = 1 and $J^P = 0^-$, it is found possible to make the Goldberger–Treiman relations agree with experiment if the resonance mass is $M_R \approx 2$ GeV. This resonance is tentatively identified with the $\bar{N}N$ resonance structure observed around 2 GeV. (auth)

13052 REGGE TRAJECTORY OF THE PION IN THE N $\bar{N}$ BETHE–SALPETER EQUATION. Lipinski, H. M. (Univ. of California, San Diego, La Jolla). Phys. Rev.; 186: 1643-8 (25 Oct 1969).

In the region near t = 0, the O(4) projected $N\bar{N}$ Bethe–Salpeter equation is solved for the pion's Regge trajectory. It is found that there are two Regge trajectories with the same quantum numbers as the pion which lie above J = −1. At t = 0, the highest-lying trajectory has Toller quantum number M = 1. The other Regge trajectory lies somewhat further below and has the Toller quantum number M = 0. In addition to the intercepts, the slopes of these trajectories are also calculated. (auth)

13053 DIRECT-CHANNEL RESONANCES IN ANTIPROTON–PROTON ELASTIC SCATTERING. Lys, J. (Univ. of Michigan, Ann Arbor). Phys. Rev.; 186: 1691-4(25 Oct 1969).

The effect of a direct-channel resonance on antiproton-proton elastic scattering is investigated. The differential cross section has a nonresonant term, a pure resonant term, and an interference term. It is not possible to say much about the interference term. The angular shape of the pure resonant term depends upon the resonance quantum numbers C and P, as well as the spin J, but in general resembles the square of the Legendre polynomial $P_J(\theta)$. The possibility of a background amplitude in the resonant partial waves affects the enhancements in the total elastic and total cross sections. (auth)

13054 ρ^-f^0 DOUBLE BOOTSTRAP BY THE BALAZS METHOD. Antippa, Adel F.; Everett, Allen E. (Tufts Univ., Medford, Mass.). Phys. Rev.; 186: 1571-82(25 Oct 1969).

The simultaneous bootstrap of the ρ and f^0 mesons was studied, using the Balázs method. When the exchange of an f^0 with physical parameters is included in the input force, it is found that an approximately self-consistent ρ with a mass of 710 MeV and full width of 100 MeV is obtained; the degree of self-consistency is somewhat improved if the width is reduced to 66 MeV. One can obtain a simultaneous bootstrap of both the ρ and f^0 with a ρ mass and full width of 710 and 46 MeV, and f^0 mass and full width of 1344 and 112 MeV, respectively. It is believed that the double-bootstrap results are somewhat affected by our approximate treatment of inelastic effects, which involves a discontinuity in the inelasticity function R_1^1 near the position of the f^0. These results are based upon taking n, the number of poles approximating the left-hand cut, equal to 7. The use of a large number of poles is important, and it is not at all clear from the n dependence of our calculations that we have yet obtained a limiting form of the results as n becomes large, even with n = 7. (auth)

13055 NEW REPRESENTATION OF THE SCATTERING AMPLITUDE. Botke, J. C.; Blankenbecler, R. (Univ. of California, Santa Barbara). Phys. Rev.; 186: 1536-9(25 Oct 1969).

A new representation of the scattering amplitude that has good analytic properties, Regge asymptotic behavior, and an arbitrary double-spectral boundary is proposed. The representation automatically yields partial waves with the correct threshold behavior for both their real and imaginary parts. The presence of the correct double-spectral boundary should be very important in decay problems, where an unstable external particle considerably modifies the analytic properties of the amplitude. This representation in its simplest version is applied to pion-pion scattering. Unitarity is enforced near threshold. By using the (degenerate) ρ- and f-meson trajectories, the ρ width and the Adler self-consistency condition, the three isotopic scattering lengths, the f width, and the Regge-scale mass are predicted. (auth)

13056 DYNAMICAL GROUP OF RELATIVISTIC OSCILLATOR AND LINEAR MESON TRAJECTORIES. Takabayasi, Takehiko (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto); 42: 1210-12(Nov 1969).

A case of a relativistic oscillator model with maximum rest symmetry is considered, and a family of linear meson trajectories is obtained similar to that implied in the conspiracy theory and the Veneziano model. The model described is regarded as an extension of a recent model. (J.F.P.)

13057 POSITIVITY BOUNDS ON PARTIAL-WAVE AMPLITUDES FROM CROSSED-CHANNEL UNITARITY. Cheung, Franklin F. K. (State Univ. of New York, Stony Brook). Phys. Rev.; 186: 1726-8(25 Oct 1969).

New constraint relations from crossed-channel unitarity are obtained for pion-pion and pion-nucleon scattering. The importance of the signature factor is pointed out. (auth)

13058 UNITARIZED VENEZIANO AMPLITUDES SATISFYING THE ADLER CONSISTENCY CONDITION. Dobson, P. N. Jr. (Univ. of Hawaii, Honolulu). Lett. Nuovo Cim.; 2: 761-4(1 Dec 1969).

The difficulty in unitarizing the scattering amplitude by interpreting the Veneziano amplitude as the K-matrix is that in general the isospin-0 and -1 amplitudes no longer vanish at the Adler point, making the choice of trajectory parameters less clear. This difficulty is avoided by devising a kinematic factor $\rho(s)$ which itself vanishes at $s = \mu^2$. Then the scattering amplitude at the Adler point reduces to the Veneziano form and the usual trajectory constraint suffices. The Lovelace form for the function $\rho(s)$ in $\pi\pi$ scattering is considered. The s-wave scattering lengths, the mass and width of the 2^+ resonance, and mass and partial width of the meson (f) are calculated. (J.F.P.)

13059 VENEZIANO MODELS FOR $\pi-\pi$ SCATTERING WITHOUT THE ρ'. Capra, F. (Univ. of California, Santa Cruz). Lett. Nuovo Cim.; 2: 768-90(1 Dec 1969).

Models which do not contain the ρ' but still retain the satisfactory features of the single-term Veneziano model are studied for the process $\pi^+ + \pi^- \to \pi^+ + \pi^-$. Restriction is made to models with two satellite terms, the necessary minimum to eliminate the ρ' and still satisfy the Adler condition. It is found that one model gives the ratio $\Gamma_\epsilon/\Gamma_\rho = \frac{1}{2}$ and at the same time gives $\Gamma_{f^0}/\Gamma_\rho > 1$ indicated by experiment. Also the s-wave scattering lengths are calculated and found to be satisfactory. However, this model gives a negative width for the ϵ^1, the s-wave daughter of the f^0. (J.F.P.)

13060 VIOLATION OF ANALYTICITY IN THE PARTIAL SUMMATION METHOD. Fukuda, Reijiro (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 42: 1208-10(Nov 1969).

Using the simplest possible nonlinear model Lagrangian it is shown that the summation technique developed previously leads to the violation of the usual analyticity and hence causality. It is

also shown that the usual analytic property (and hence causality) of any diagram and the unitarity to the order χ^2 can be restored. The unitarity of the S-matrix is explicitly shown for a given diagram. (J.F.P.)

13061 REGGE POLE CONTRIBUTION OF $\pi\pi \simeq$ NN AMPLITUDE AND THE ISO-VECTOR PART OF NUCLEON ELECTROMAGNETIC FORM FACTORS. Watanabe, Keiji (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto); 42: 1212-14(Nov 1969).

The Regge pole effect on the two-pion contribution for the nucleon electromagnetic form factors is evaluated. The results are given and found to agree with experimental data. (J.F.P.)

13062 DECAY AND THE VENEZIANO MODEL. Matinyan, S. G.; Kharbediya, L. I. (Inst. of Physics, Tbilisi, USSR). JETP Lett. (USSR) (Engl. Transl.); 10: 168-9(20 Sep 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu; 10: 265-6(20 Sep 1969).

It is shown that the Veneziano model for the amplitudes of $\omega \to 3\pi$ decay leads to a correct value for the total width of the ω meson. The distribution with respect to the square of the mass of the $\pi^+\pi^0$ system in ω decay, which follows from the Veneziano formula, is compared with that obtained in the crossing-symmetric Breit-Wigner model. (L.B.S.)

13063 PSEUDOSCALAR-VECTOR SCATTERING AND THE NONET SCHEME IN THE VENEZIANO MODEL. Itabashi, Kiyomi; Kohsaka, Yasutsugu; Miyake, Shogo; Takagi, Fujio (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto); 42: 1151-65 (Nov 1969).

The Veneziano-type amplitudes for $P_8V_9 \to P_8V_9$ and $P_8P_8 \to P_8V_9$ scattering are constructed. From these amplitudes, several sum rules for the $V_9P_8P_8$, $V_9V_9P_8$, $T_9P_8P_8$ and $T_9V_9P_8$ coupling constants are obtained, which are consistent with the SU(3) symmetry and Okubo's nonet ansatz. In particular the universality relation $g_{\rho\pi\pi} = 2g_{\rho KK}$ is obtained. Here P_8, V_9 and T_9 denote the pseudoscalar meson octet, the vector and the tensor meson nonets, respectively. An exchange degeneracy scheme for meson trajectories is proposed; $\alpha_{P_{8+1}} = \alpha_{A_{8+1}}$ and $\alpha_{V_9} = \alpha_{T_9}$, where α means the trajectory function. In the case of $P_8V_9 \to P_8V_9$, a problem on parity doubling is discussed briefly. (auth)

13064 CONNECTIONS BETWEEN THE HIGH-ENERGY BEHAVIOR OF RESONANCES AND UNITARITY. Paciello, M. L. (Univ., Rome); Taglienti, B.; Sertorio, L. Contract F 61-05267-C-0084. Nuovo Cim.; 65A: 167-87(1 Jan 1970).

An attempt is made, with the aid of a model, of connecting the existence of infinite resonances with increasing mass to the Regge asymptotic behavior, via inelastic unitarity. This process might be considered as a Reggeization threshold by threshold, with a simplified analytic structure which preserves crossing symmetry by sight. This last point is somewhat reminiscent of Veneziano. (auth)

13065 GENERALIZATION OF THE VENEZIANO MODEL TO THE SCATTERING OF BOSONS WITH ARBITRARY SPINS. Dietz, K.; Roemer, H. (Univ., Bonn). Nuovo Cim.; 65A: 229-44(1 Jan 1970).

A dual scattering amplitude for the scattering of particles with any integer spins is derived. Helicity amplitudes are used for the construction, and kinematical constraints are explicitly fulfilled. Parity doubling of trajectories is discussed. π-ρ scattering is treated as an illustrative example. (auth)

13066 HARD KAON AND PION CALCULATIONS OF THE DECAYS $K_A \to K\rho$ AND $K_A \to K^*\pi$. Srivastava, Prem P. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). Notas Fis., Cent. Brasil. Pesqui. Fis.; 14: 295-318(1968).

The strong decays $K_A \to K\rho$, $K^*\pi$ are discussed in a current algebra approach by writing unsubtracted dispersion relations for the matrix elements of appropriate retarded commutators of currents or current divergences between single particle states and vacuum, at (arbitrary) fixed linear combination of the two momentum transfers. This enables one to retain the pole contributions from both the variables. Moreover, the various form factors appearing in the calculation are allowed to satisfy at most once subtracted dispersion relations and are treated on equal footing. The current algebra method is used to set up sum rules among the coupling constants and the subtraction constants without using the hypothesis of partial conservation of axial current. Their solution allows one to calculate the partial decay widths as well as the Weinberg sum rules which are rederived as self-consistency conditions. (auth)

13067 PARTIALLY CONSERVED DILATATION AND SPECIAL LIOUVILLE CURRENTS COMBINED WITH CHIRAL CURRENT ALGEBRAS. Cin, M. Dal; Kastrup, H. A. (Univ., Munich). Nucl. Phys.; B15: 189-98(1970).

Combining recent results from an analysis of partially broken dilatation and special Liouville (conformal) symmetries with the concepts of chiral $SU_2 \times SU_2$ and $SU_3 \times SU_3$ algebras of currents yields predictions for the following quantities: The width of the $\sigma(700)$, s-wave pion-pion scattering lengths, the σ-contribution to the pion-pion Adler-Weisberger sum rule, the partial widths of the $\eta_{8+}(1070)$ and—in the framework of SU_3—the partial widths for the other members of the nonet of scalar mesons. Almost all predictions are in good agreement with available data. (auth)

13068 SUM RULE FOR THE I = 0, S-WAVE PHASE SHIFT IN MESON-MESON SCATTERING FROM BROKEN LIOUVILLE SYMMETRY. Kastrup, H. S. (Univ., Munich). Nucl. Phys.; B15: 179-88(1970).

Starting from the equal-time commutators of the time-dependent generators $D(x^0)$ and $K_\mu(x^0)$, $\mu = 0, 1, 2, 3$, of the dilatations and the special Liouville (conformal) transformations with the interpolating fields $\varphi_\alpha(x)$ of scalar or pseudoscalar hadrons, it is possible to derive an interesting sum rule for the I = 0, s-wave scattering phase shift of these mesons. The sum rule shows—among other things—that the dimension of length of the fields $\varphi_\alpha(x)$ is intimately related to the number of resonances in their I = 0, s-wave scattering channel: Canonical field theory predicts three such resonances. Finally, a scalar meson dominance model for the divergence of the dilatation current gives relations between several quantities of these resonances. (auth)

13069 COVARIANT ONE-PARTICLE APPROXIMATION TO CHIRAL ALGEBRA AND THE $\pi\,\rho\,A_1$ SYSTEM. Dahmen, Hans D.; Rothe, Klaus D. (Univ., Heidelberg). Nucl. Phys.; B15: 77-88 (1970).

A direct saturation of the commutation relations of axial charges with isospin currents is shown to lead in the covariant one particle approximation to frame independent relations among weak form factors. Assuming the absence of I = 1 operator Schwinger terms, values for the weak decay constants f_A and f_ρ and the width $\Gamma_{A\rho\pi}$ of the A_1 meson are obtained in reasonable agreement with experiment. (auth)

13070 CURRENT ALGEBRA AND $\pi\pi$ SCATTERING LENGTHS. Dahmen, Hans D.; Rothe, Klaus D. (Univ., Heidelberg). Nucl. Phys.; B15: 45-55(1970).

Starting from the SU(2) × SU(2) commutation relations for the axial vector charges, a Low representation is derived for the combination $2a_0 - 5a_2$ of the $\pi\pi$ scattering lengths, which involves explicitly the low-energy results plus correction terms. The corrections are estimated by considering in addition canonical commutation relations for the divergence of the axial vector current A^π_μ, and assuming the integrals to be dominated by an isoscalar, s-wave $\pi\pi$ resonance. The approximation is crossing symmetric and includes the effect of the unitarity cut. (auth)

13071 THE $f^0 \to 4\pi$ DECAY IN CHIRAL DYNAMICS. Banyai, L.; Rittenberg, V. (Inst. of Physics, Bucharest). Nucl. Phys.; B15: 199-204(1970).

The $f^0 \to 4\pi$ decay was computed using effective Lagrangian techniques and the following branching ratios were obtained neglecting direct $f^0 \to \rho\rho$ couplings $f^0 \to 2\pi^+2\pi^-/f^0 \to \pi^+\pi^- = 4.4\%$; $f^0 \to 4\pi^0/f^0 \to \pi^+\pi^- = 0.96 \cdot 10^{-2}\%$. Different decay distributions were also computed. (auth)

13072 INTERPOLATION OF A SCATTERING AMPLITUDE BETWEEN INTEGRAL VALUES OF AN EXTERNAL SPIN. Thiebaux, M. L. (Univ. of Massachusetts, Amherst). Phys. Rev.; 186: 1560-7(25 Oct 1969).

It is shown that the π^* inverse-production amplitude in the reaction $\pi^*\pi \to \pi\pi$, where π^* is a pionlike particle of any spin, can be interpolated in a physically meaningful way between integral-spin values of the π^*. A unique interpolation is obtained by formally treating the π^* as though it had spacelike four-momentum, for which the spectrum of the angular momentum is continuous, and then analytically continuing the amplitude in the invariant square of the π^* four-momentum to timelike values. This procedure selects one of two equally "natural" interpolations. The selected interpolation is then shown to be compatible with the requirement of constructing partial-wave amplitudes, containing the ρ, that have factorizable singularities analytic in the spin of the π^*, while the other selection is forbidden by this requirement. An independent procedure, paralleling the usual Froissart-Gribov rule, also is shown to select the same favored interpolation of the partial-wave amplitude. (auth)

13073 SUPERCONVERGENT DISPERSION RELATIONS AND PION-PION SCATTERING SUM RULE. Acharya, R. (Univ.,

Bern); Aly, H. H.; Narayanaswamy, P. Phys. Rev.; 186: 1567-70(25 Oct 1969).

An alternative derivation based on the technique of asymptotic symmetry is given for the pion-pion scattering sum rule. A new asymptotic symmetry hypothesis is proposed in terms of the proper amplitudes, which has the merit of narrowing the discrepancy between experiment and the Adler sum rule. (auth)

13074 NOTE ON PARALLEL BOSON TRAJECTORIES. Peaslee, D. C. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev.; 187: 1948-9(25 Nov 1969).

Direct empirical testing with boson masses is proposed for the popular hypothesis —obtained indirectly from virtual boson exchange —that all boson trajectories are parallel and that most are exchange-degenerate, also. It turns out that presently well-determined resonances are not quite sufficient to decide for or against the hypothesis, but that the next stage of measurement should be critical. In particular, four charged-meson states with $J^P = 2^-$ should be sought in the mass region ~1.4–1.6 BeV, where experiments to date show a dearth of resonances. If the hypothesis of a single slope is correct, present data indicate the universal trajectory type to be $\frac{1}{2}(J + L) \approx u + \alpha(0)$, where u is in BeV^2, and J and L are the total and orbital angular momenta, respectively, on a baryon-antibaryon model. All trajectories can be made exchange degenerate except for the ^1L_L case. The intercepts $\alpha(0)$ do not generally assume half-integer values, but $\alpha_\pi + 3\alpha_\eta \approx 4\alpha_K$ for all orbital types, which suggests little over-all SU_3 octet-singlet mixing between trajectories. (auth)

13075 NONEVASIVE CHEW-LOW EXTRAPOLATION FOR THE STUDY OF $\pi\pi$ ELASTIC SCATTERING. Froggatt, C. D. (University Coll., London); Morgan, D. Phys. Rev.; 187: 2044-6(25 Nov 1969).

A recent analysis of (+−) dipion production indicates that the extrapolated production cross section does not vanish at t = 0 as it would for one-pion exchange. A model is presented for this phenomenon in which the spin and dipion mass dependences of the background are simply parametrized. This suggests a new prescription for performing Chew-Low extrapolation. (auth)

13076 OVERLAPPING RESONANCES IN THREE-MESON STATES. Snoke, J. Arthur (Yale Univ., New Haven). Phys. Rev.; 187: 2096-2106(25 Nov 1969).

A system of three pseudoscalar mesons is considered in which one of the mesons can form a two-particle resonance with either of the other two. The models discussed include the Lee model, approximations to the Lee model, and a fully relativistic isobar model. As an example for the nonstatic model the 3π state containing two overlapping, identical ρ resonances is discussed. There have been claims that resonance projections can lead to enhancements in the three-particle mass when there are overlapping two-particle resonances. It is shown that these enhancements are caused by approximations which are not actually resonance projections, and for these models that properly made resonance projections do not lead to enhancements. Some alternatives to the isobar model for treating overlapping resonances are briefly discussed. (auth)

13077 UPPER BOUNDS FOR COUPLING CONSTANTS FROM THE VENEZIANO MODEL. Finkelstein, Jerome (Stanford Univ., Calif.). Phys. Rev.; 187: 2189-91(25 Nov 1969).

It is shown that by adding a term representing the Pomeranchon to the Veneziano model for $\pi\pi$ scattering, and by enforcing unitarity, one can obtain an upper bound for the ρ width of $\Gamma_\rho \lesssim 94$ MeV, and an estimate of the asymptotic value of the $\pi\pi$ total cross section of about 13 mb. (auth)

13078 $\bar{p}p \rightarrow \bar{\Lambda}\Lambda$ REACTION. Kwak, N.; Nicholas, M. L. (Univ. of Kansas, Lawrence). Phys. Rev.; 187: 2088-92(25 Nov 1969).

The O(3,1) symmetry model is used to evaluate the differential cross section and spin correlations for the reaction $\bar{p}p \rightarrow \bar{\Lambda}\Lambda$ at various energies. Fairly satisfactory agreement is found for the differential cross section except perhaps for the 7-GeV/c data. The spin correlations for 2.19 GeV/c are found to be qualitatively consistent with experiment. (auth)

13079 DUALITY AND $\pi\pi$ SCATTERING LENGTHS. Suzuki, Mahiko (Tokyo Univ.). Phys. Rev.; 187: 2222-6(25 Nov 1969).

The s-wave $\pi\pi$ scattering lengths are discussed generally in duality models. Bounds on the scattering lengths are obtained on the assumption that resonances can be treated like stable particles. These bounds, which are valid for arbitrary nonlinear trajectories, too, are compatible with the conventional current-algebra results if duality holds, but not if the interference model is valid. (auth)

13080 GENERAL TREATMENT OF $\pi\pi \rightarrow \pi A_1$ IN THE VENEZIANO MODEL. Rosner, Jonathan L.; Suura, Hiroshi (Argonne National Lab., Ill., Univ. of Minnesota, Minneapolis). Contract AT(11-1)-1764. Phys. Rev.; 187: 1905-12(25 Nov 1969).

A two-parameter Veneziano-type model for $\pi\pi \rightarrow \pi A_1$ is discussed from the standpoints of (1) constraints due to partial conservation of axial-vector current, (2) the pion electromagnetic form factor, and (3) partial widths $\Gamma(X \rightarrow A_1\pi)$ for X along the leading trajectory. (auth)

Strong (Baryon No. = 1)

Refer also to abstracts 12948, 12976, and 13057.

13081 (INP–682, pp 138-55) APPLICATIONS OF FINITE ENERGY SUM RULES. Phillips, R. J. N. (Rutherford High Energy Lab., Chilton (England)).

Finite-energy sum rules are used for analyticity relations between low- and high-energy scattering amplitudes in order to obtain information on high-energy scattering amplitudes. The example of π + N scattering at fixed t is given. (J.F.P.)

13082 (SU–1206-218) REGGE-POLE EIKONAL THEORY OF SMALL-ANGLE K_2^0-NUCLEON SCATTERING. Blackmon, Maurice L. (Syracuse Univ., N. Y. Dept. of Physics); Goldstein, Gary R. (Tufts Univ., Medford, Mass. Dept. of Physics). Dec 1969. 11p. (NYO–3399-218). Dep. CFSTI.

A Regge-pole model with absorptive corrections is used to calculate the differential cross sections and polarizations for the reactions $K_2^0p \rightarrow K_1^0p$ and $K_2^0p \rightarrow K_2^0p$. (auth)

13083 STUDY OF AN S-MATRIX MODEL FOR THE THREE-BODY DECAY OF A SPINNING RESONANCE. Tucker, R. W. (Univ. of Massachusetts, Amherst). Phys. Rev.; 186: 1598-1618(25 Oct 1969).

In this model the strong interaction producing the three-body decay of a spinning hadron is governed by the analytic continuation of resonant structures in the crossed scattering channels. Attention is given to the correspondence between the variables describing the configuration of the full decay amplitude and the kinematic invariants describing the scattering channels. Two-body scattering amplitudes free of kinematic singularities and physical threshold zeros are parametrized in terms of resonance poles, and crossing relations are developed to relate them to the three-body decay amplitudes. The formalism is applied to study the ($\pi\Sigma$) mass spectra for the process $Y_1^* \rightarrow \Sigma\pi\pi$. (auth)

13084 EXPERIMENTAL ASPECTS OF DUAL THEORIES FOR BARYONS. Barger, V.; Michael, C. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Rev.; 186: 1592-7(25 Oct 1969).

Formulations of baryon-exchange-degenerate schemes incorporating SU(3) symmetry are presented. The relevance of the SU(3) solutions to the baryon spectrum and backward-scattering data is discussed and a more empirical broken-SU(3) approach to reconcile the duality constraints with experiment is presented. (auth)

13085 $\alpha = 0$ WRONG-SIGNATURE POLE IN πN CHARGE EXCHANGE. Aviv, R.; Horn, D. (Tel-Aviv Univ., Israel). Phys. Rev.; 186: 1510-13(25 Oct 1969).

Use is made of partial conservation of the axial-vector current and the finite-energy sum rules to investigate poles at the wrong-signature points in πN scattering amplitudes, and it is shown that a wrong-signature pole at $\alpha = 0$ appears only in the helicity-flip amplitude. (auth)

13086 SURFACE-WAVE DESCRIPTION OF π^+p BACKWARD SCATTERING. Bryant, Howard C. (Stanford Univ., Calif.). Phys. Rev.; 186: 1488-90(25 Oct 1969).

The results of fitting the Regge-pole portion of the amplitude of Nussenzveig's impenetrable-sphere solution to π^+p backward-scattering measurements are reported. The fits, which require determination of the location of a pole in the complex angular momentum plane (two parameters), are made to data at 14 different energies from 2 to 17 GeV, and range in quality from good to indifferent. The locus of fitted poles on the angular momentum plane determines a trajectory similar to, but closer to the real axis than, that of the lowest Nussenzveig-Regge surface pole. A study of fits at 5.2 and 6.9 GeV/c, in which the over-all normalization of the data was varied, indicates that the magnitude of the backscattered-pion cross section is near optimum for consistency with the surface-wave description. (auth)

13087 Y_1^*NK COUPLING FROM DISPERSION THEORY SUM RULES. Agarwal, B. K.; Sharma, M. C.; Seth, V. P. (Allahabad Univ., India). Lett. Nuovo Cim.; 2: 758-60(1 Dec 1969).

Previous sum rules, from a comparison of fixed-t and fixed-u unsubtracted dispersion relations, are set up for KN elastic scattering, and these sum rules are used to obtain information on $\Sigma(1385)$NK coupling. The combination (KN + $\overline{K}$N) of elastic processes, for which ρ is the leading Regge trajectory in the t-channel, is considered. It is found that the simple dispersion theory sum rules can be used to yield information on coupling constants by saturating them just with low-lying states. (J.F.P.)

13088 ADDITIVITY ASSUMPTION AND SCALING FACTOR IN THE REGGE THEORY. Kobayashi, Reido (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 42: 1217-19(Nov 1969).

In order to obtain complete agreement with experiment, some relations among total cross sections for meson–baryon and baryon–total cross sections, which were previously analyzed in the framework of the Regge pole model using a previous plot of the experimental data, are explained. (J.F.P.)

13089 BARYON DECAYS AND REGGE RECURRENCE SERIES. Kawasaki, Mamoru; Kobayashi, Masanori; Moritomo, Syuhei (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 42: 1206-8(Nov 1969).

The properties of baryon–meson vertices are discussed in connection with the Regge recurrence series. The processes $\Delta_\delta \to N_\gamma + \pi$ and $N_\gamma \to N + \pi$ are discussed, and an attempt is made to generalize the information for these decays to give the angular momentum dependence of the coupling constants of baryon decays. The decay $\Delta_\delta \to N_\gamma + \pi$ is considered a member of $\Delta_\delta \to N_\alpha + \pi$ decay and has a similar angular momentum dependence of the coupling constants. It is found that the angular momentum dependence of the obtained coupling constants is not inconsistent with the observed widths and also with the experimental situation of the various processes of which the widths are not obtained. (J.F.P.)

13090 SEMI-THEORETICAL FORMULA FOR THE BARYON MASS SPECTRA. Rosen, G. (Drexel Inst. of Tech., Philadelphia). Lett. Nuovo Cim.; 2: 747-8(1 Dec 1969).

From a formula for the baryon octuplet and resonance decuplet mass operator, in terms of the operators for physical hypercharge and isospin, the formula for the baryon mass spectra is obtained. This formula gives mass values for the isospin multiplets of the octuplet and of the decuplet. These values are listed and compared with experiment. It is noted that assuming the validity of the mass operator formula, it follows that the electromagnetic coupling constant modulates the medium strong interaction which breaks SU(3) symmetry. (J.F.P.)

13091 FORWARD K–$\mathcal{N}$ SCATTERING AND A NEW INTERFERENCE MODEL. Karasuno, T. (Osaka City Univ.). Lett. Nuovo Cim.; 2: 749-51(1 Dec 1969).

It is examined whether or not kaon–nucleon scattering in the intermediate-energy region can satisfactorily be described in terms of a recent interference model. Forward K + N elastic scattering is considered. It is concluded that K^-p and K^-n total cross section data for 0.6 to 4 GeV/c can be well fitted using this interference model. (J.F.P.)

13092 PREDICTIONS FOR THE DECAY DISTRIBUTIONS OF RESONANCES PRODUCED IN THE REACTIONS $0^- \tfrac{1}{2}^+ \to 1^- \tfrac{3}{2}^+$ WITH POLARIZED INITIAL BARYONS. Kotanski, Andrzej Jagellonian Univ., Krakow); Zalewski, Kacper. Nucl. Phys.; B15: 242-52(1970).

The quark model is used to predict the joint decay distributions of the pairs of resonances produced in the reactions $0^-\tfrac{1}{2}^+ \to 1^-\tfrac{3}{2}^+$ with polarized initial baryons. Explicit numerical predictions for the processes $\pi^+p \to \omega N^{*2+}$ at 8 GeV/c, $\pi^+p \to \rho^0 N^{*2+}$ at 8 GeV/c and $K^+p \to K^{*0}N^{*2+}$ at 5 GeV/c are given. Experimental results obtained with the initial protons polarized in the reaction plane can be used to resolve an ambiguity in the interpretation of the additivity assumption in the quark model. (auth)

13093 ALGEBRAIC STRUCTURE OF WEINBERG'S FIRST SUPERCONVERGENCE CONDITION. Cronstroem, C.; Noga, M. (Univ. of Helsinki). Nucl. Phys.; B15: 61-6(1970).

It is shown that Weinberg's first superconvergence condition for p-wave hadron interaction leads to the group SU(2) ⊗ SU(4). A few p-wave decay rates are calculated and found to agree well with experiment. (auth)

13094 RHO-DOMINANT SUM RULES FOR KAON–NUCLEON SCATTERING. Pundari, S. Baba; Banerjee, H.; Dutta-Roy, B. (Saha Inst. of Nuclear Physics, Calcutta). Nucl. Phys.; B15: 221-8(1970).

A new set of sum rules are presented for the helicity non-flip amplitude, the helicity-flip amplitude B, and the amplitude A for kaon–nucleon scattering corresponding to t-channel isospin and G-parity $I^G = 1^+$. These sum rules are derived assuming unsubtracted dispersion relations for these amplitudes both in the forward as well as in the backward directions and that the ρ-meson dominates in the $I^G = 1^+$ channel. The sum rules are in excellent agreement with the available experimental data. The analysis vindicates the hypothesis of universal ρ-coupling to hadrons. (auth)

13095 UNITARITY, CROSSING, AND TWO-BODY EFFECTS IN A LOW-ENERGY PRODUCTION MODEL. Humble, Stephen (Univ. of Colorado, Boulder). Nucl. Phys.; B15: 299-315 (1970).

A model for single-particle production processes is proposed which takes account of two-particle interactions in all channels. It is the generalization of the Taha final state model and the Zimmerman crossing symmetric K-matrix equation. Neglecting nucleon spin, some simple low-order iterations to the integral equations for pion–nucleon single-pion production are calculated. Besides the two-body amplitudes which are presumed known, the only input is an overall scale. It is shown that even the low-order iterations are in fair agreement with some mass and angular distributions at low energies. The generalization of the model to include spin effects and its relation to other production models are briefly discussed. (auth)

13096 TREATMENT OF $\pi N \to K\Lambda$ AND $\pi N \to K\Sigma$ WITH A VENEZIANO TYPE MODEL. Schmidt, M. G. (Univ., Heidelberg). Nucl. Phys.; B15: 157-78(1970).

The processes $\pi N \to K\Lambda$ and $\pi N \to K\Sigma$ and the corresponding crossed reactions $\overline{K}N \to \pi\Lambda$ and $\overline{K}N \to \pi\Sigma$ are studied simultaneously. A simple Veneziano type ansatz for the invariant amplitudes of these processes with only three free parameters in each case is given. In each isospin channel, there is at most one (possibly degenerate) trajectory, together with its daughters. Veneziano terms for which there is no allowed duality diagram are omitted. The parameters can be chosen such that the high-energy data (magnitude and slope of forward and backward peak) fit well. With these parameters the resonance spectrum in all channels is described satisfactorily. Parity doubling of baryon resonances occurs. However, the parity partners which are not seen so far turn out to have very small widths as a result of kinematic suppression. The products of partial widths of the well-known Y_0, Y_1 and Δ-resonances are found to be in good agreement with experimental data. (auth)

13097 FERMION REGGEIZATION WITHOUT PARITY DOUBLING. Carlitz, R.; Kislinger, M. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Phys. Rev. Lett.; 24: 186-9(26 Jan 1970).

The common belief that fermions lying on linear trajectories must have opposite-parity partners is shown to be false. Reggeization of a sequence of positive-parity fermion resonances is carried out in the Van Hove model. As a consequence of the absence of negative-parity states, the partial-wave amplitudes must have a fixed cut in the J plane. This fixed cut, in conjunction with the moving Regge pole, provides a new parametrization for fermion-exchange reactions, which is in qualitative agreement with the data. (auth)

13098 ISOLATION OF POMERANCHUK CONTRIBUTION TO $\overline{K}N$, $\overline{p}N$, AND πN TOTAL CROSS SECTIONS. Trilling, George H. (Univ. of California, Berkeley). Phys. Rev. Lett.; 24: 177-80 (26 Jan 1970).

A procedure for isolating the Pomeranchuk contribution to total cross sections is suggested. Application to the K^-N and $\overline{p}N$ systems yields the same value within errors as for the K^+N and pN systems, respectively, in agreement with the Pomeranchuk theorem. For πN, an asymptotic cross section of $18.1^{+}_{-}{}^{0.7}_{0.5}$ mb is obtained. (auth)

13099 s-CHANNEL PICTURE FOR REGGEON COUPLINGS TO BARYONS. Rosner, Jonathan L. (Univ. of Minnesota, Minneapolis). Phys. Rev. Lett.; 24: 173-6(26 Jan 1970).

A simple s-channel picture of the dominant non-Pomeranchuk contributions to the A′ amplitude in 0^- meson-$\frac{1}{2}^+$-baryon scattering leads to (i) a physical interpretation of the F parameter in Reggeon and tadpole couplings to baryons, and (ii) selection rules for baryon couplings to mesons and baryons. (auth)

13100 REGGE ANALYSIS OF ASYMPTOTICALLY UNEQUAL $K^\pm p$ TOTAL CROSS SECTIONS. Finkelstein, Jerome (Stanford Univ., Calif.). Phys. Rev. Lett.; 24: 172-3(26 Jan 1970).

The possibility of a violation of the Pomeranchuk theorem, as suggested by recent Serpukhov data, is discussed in terms of Regge singularities. At $t = 0$, a simple Regge pole of odd-charge conjugation is required, but for $t \neq 0$, the singularity structure in the J plane must be more complicated. (auth)

13101 GENERALIZED ANGULAR MOMENTUM CROSSING RELATION. Fairlie, D. B. (Univ. of Durham, Eng.); Noga, M. T. Ann. Phys. (N. Y.); 56: 58-68(Jan 1970).

In low-energy meson-baryon scattering a specific partial wave amplitude in the direct channel contains contributions from the exchange of resonances in all partial waves in the crossed channel. These contributions, first considered by Carruthers for pion-nucleon scattering, are evaluated in the limit where the baryon kinetic energy is small compared to its mass, and expressed succinctly in terms of a 9j symbol. Consequences for bootstrap theory are noted. (auth)

13102 REGGEIZED U(6) × U(6) × O(3) AND ABSORPTIVE CORRECTION CUTS FOR $0^-\frac{1}{2}^+ \to 0^-\frac{1}{2}^+$ CHARGE-EXCHANGE REACTIONS. Hartley, B. J.; Moore, R. W.; Moriarty, K. J. M. (Imperial Coll. of Science and Tech., London). Phys. Rev.; 187: 1921-31(25 Nov 1969).

Reggeized U(6) × U(6) × O(3) with absorptive corrections is applied to some $0^-\frac{1}{2}^+ \to 0^-\frac{1}{2}^+$ charge-exchange processes. The differential cross sections for $\pi^-p \to \pi^0n$ and $\pi^-p \to \eta^0n$ are used to fix the parameters of the ρ and A_2 trajectories, respectively. With these parameters, an absolute prediction is made for the process $K^-p \to \bar{K}^0n$. The agreement with experiment is good. The polarization parameter P(t) and the Wolfenstein parameters A(t) and R(t) are also presented. (auth)

13103 CALCULATION OF KN AND $\bar{K}N$ SCATTERING LENGTHS AND PHASE SHIFTS BY A POLE-DOMINANCE METHOD. Sanda, A. I. (Princeton Univ., N. J.). Phys. Rev.; 187: 1975-83(25 Nov 1969).

Recently, a procedure for representing a two-particle scattering amplitude as a sum of resonances in all three channels was derived by Schwarz. In addition to satisfying crossing symmetry, such a formula has a large domain of validity in the (s,t,u) plane. This method is applied here to KN and $\bar{K}N$ scattering. The experimental parameters for the scattering are calculated in the low-energy region. They are (1) the s-wave scattering lengths for KN isospin-zero and -one channels; (2) the S_{01}, P_{01}, S_{11}, P_{11}, P_{13}, and D_{13} phase shifts (S_{lj} denotes the s-wave isospin i and angular momentum $\frac{1}{2}j$) for scattering in the energy region up to center-of-mass momentum 0.3 GeV/c; (3) the real part of the s-wave scattering lengths for $\bar{K}N$ isospin-zero and -one channels. In addition, a sum rule relating amplitudes of the KN channel and the $\bar{K}N$ channel is obtained. It is well satisfied for the real part of the amplitude and is not satisfied for the imaginary part. (auth)

13104 THEORY OF THE D_{13} PION–NUCLEON AMPLITUDE. Aaron, R. (Northeastern Univ., Boston); Teplitz, D. C.; Amado, R. D.; Young, J. E. Phys. Rev.; 187: 2047-51(25 Nov 1969).

The π-N scattering amplitude is calculated in the D_{13} channel using the relativistic, unitary three-body theory extended to include a p-wave π-π interaction. The sharp π-N resonance and corresponding dip in the inelasticity are obtained with reasonable π-π parameters. ρ production seems to have little effect in the F_{15} state. (auth)

13105 MODIFIED TAMM–DANCOFF APPROACH TO CHARGED-SCALAR THEORY. Maxon, M. Stephen (Univ. of California, Livermore). Phys. Rev.; 187: 2129-41(25 Nov 1969).

A scheme for truncating the τ-function equations appropriate to charged-scalar-meson theory is presented and solved in the one- and two-meson approximations. The basis of the truncation scheme is a restriction of the number of mesons occurring in bare intermediate states. The resulting equations are modified so that the same diagrams which account for the dressing of the nucleon also account for meson-nucleon scattering. A meson-nucleon bound state is present, for large enough coupling constant, in the two-meson approximation. It occurs in the channel where the interaction takes place entirely through exchange diagrams. It is found that the masses and cutoff function of the theory can be chosen in such a way that the probability of finding the physical particle as a bare particle decreases in going from the one-meson to the two-meson approximation. (auth)

13106 SU(3) MULTIPLET MIXING AND UNITARITY. Brehm, J. J.; Cook, L. F. (Univ. of Massachusetts, Amherst). Phys. Rev.; 187: 2174-85(25 Nov 1969).

A purely S-matrix approach to SU(3) multiplet mixing is given. Particular attention is devoted to the role of strong mixing in the basis states of the S matrix itself and to the role of the inelastic channels in calculating mixed representations. The dependence of the mixed wave functions on the energy separation between resonances and on the magnitude of symmetry-violating vertices is considered. The analysis is applied to the single-octet mixing of the $\frac{3}{2}^-$ baryon system in terms of a multichannel model involving the states B_8P_8, B_8V_8, and B_8V_1. The effects of ϕ-ω mixing in the basis states are included in the calculation and a dramatic improvement between the experimental and theoretical values of the branching ratios for the decays of $\Lambda(1520)$ and $\Lambda'(1700)$ into $\bar{K}N$ and $\pi\Sigma$ is obtained. (auth)

13107 π^-p CHARGE-EXCHANGE DIFFERENTIAL CROSS SECTION AND POLARIZATION IN A REGGE-POLE MODEL. Ahmadzadeh, Akbar; Jackson, Jane C. (Arizona State Univ., Tempe). Phys. Rev.; 187: 2078-80(25 Nov 1969).

Regge-pole fits to π^-p charge-exchange differential-cross-section and polarization data have been given at moderately high energies and over a wide range of momentum transfers. Besides the ρ trajectory, whose slope and intercept are determined by exchange degeneracy, a conspiring ρ' trajectory of the same slope but intercept near zero has been taken into account. In the spirit of the Veneziano formula, the residues are assumed to be of the form const/$\Gamma(\alpha)$. A four-parameter fit gives good agreement with the experimental data. (auth)

13108 TWO-VARIABLE EXPANSION OF THE SCATTERING AMPLITUDE FOR ANY MASS AND CROSSING SYMMETRY FOR PARTIAL WAVES. Balachandran, A. P. (Syracuse Univ., N. Y.); Meggs, W. J.; Ramond, P.; Nuyts, J. Phys. Rev.; 187: 2080-7 (25 Nov 1969).

A two-variable expansion of the scattering amplitude for the process a + b → c + d is proposed, where a, b, c, and d are spinless particles of arbitrary mass. It is diagonal in angular momentum, displays the threshold and pseudothreshold behavior of partial waves, and leads to sum rules which contain a finite number of partial waves due to the crossing symmetry of the collision amplitude. The results of the previous work are recovered when the masses are equal. The reaction $\pi + N \to \pi + N$ is treated with the inclusion of nucleon spin. The expansion is valid over the Dalitz plot for a decay amplitude. A simple method to derive sum rules which relate a finite number of partial waves without the use of the two-variable expansion is also outlined. (auth)

13109 DUALITY AND THE POMERANCHUK SINGULARITY. Harari, Haim; Zarmi, Yair (Weizmann Inst. of Science, Rehovot, Israel). Phys. Rev.; 187: 2230-44(25 Nov 1969).

The conjecture on the role played by the Pomeranchuk singularity in finite-energy sum-rule (FESR) calculations and within the duality framework is reviewed and subjected to various experimental tests. It is assumed that in the FESR sense the Pomeranchon is built from nonresonating background contributions, while all other trajectories are constructed from s-channel resonance. Previous results based on this conjecture are reviewed first. A detailed model for πN elastic scattering is then compared with experiment. All I = 1 t-channel amplitudes for πN scattering are entirely accounted for by the N*-resonance contributions, while the I = 0 t-channel amplitudes require significant nonresonating background. This background is predominantly imaginary, and is presumably associated with the Pomeranchon-exchange term. The residue functions of the P and P′ trajectories are calculated, using FESR and assuming our conjecture. The calculated functions are then used to predict high-energy differential cross sections and polarizations for πN scattering, in reasonable agreement with experiment. The P′ trajectory seems to favor the Gell-Mann ghost-eliminating mechanism both in πN and in KN elastic scattering. Inelastic processes such as $K^+n \to K^0p$, $KN \to K\Delta$, and $KN \to K^*N$ are predicted to have purely real amplitudes at large s and small t. Various phenomenological models are shown to be consistent with this prediction. The paper concludes with a few remarks concerning various properties of the Pomeranchon, the connection of the model with multiparticle production and to photon initiated reactions, and the (only) failure of the model in baryon-antibaryon scattering. (auth)

13110 RECIPROCAL BOOTSTRAP MODEL. Chen-Cheung, Fei S.; (St. John's Univ., Jamacia, N. Y.); Cutkosky, R. E. Phys. Rev.; 187: 2245-8(25 Nov 1969).

Through the use of a nonlinear equation for the Bethe–Salpeter amplitude, the reciprocal bootstrap model of the $N(I,J^P = \frac{1}{2}, \frac{1}{2}^+)$ and $\Delta(I,J^P = \frac{3}{2}, \frac{1}{2}^+)$ baryons is studied. The results are compared with some of the consequences of the N/D method, the linear Bethe–Salpeter equation, and an approximation to the nonlinear equation. (auth)

13111 MESON REGGE EXCHANGES FROM SIMULTANEOUS ANALYSIS OF πN SCATTERING DATA AND DISPERSION SUM RULES. Barger, V. (Univ. of Wisconsin, Madison); Phillips, R. J. N. Contract AT(11-1)-881. Phys. Rev.; 187: 2210-21 (25 Nov 1969). (COO-881-223).

An analysis of high-energy πN scattering is made, through the range $0 \le t \le 2$ (Gev/c)^2, in terms of P, P′, P″, ρ, and ρ' Regge poles. High-energy data are supplemented by continuous-moment

sum rules that exploit low-energy data through analyticity. Predictions are made for a range of current and future experiments. (auth)

13112 EQUAL-TIME COMMUTATOR AND SUPERCONVERGENCE SUM RULE. Tomozawa, Yukio (Univ. of Michigan, Ann Arbor). Phys. Rev.; 187: 2269-70(25 Nov 1969).

An unambiguous derivation of the superconvergence sum rule from the equal-time commutation relation is presented. It can then be shown that the canonical commutation relations of meson fields lead to the superconvergence sum rules of higher moments. (auth)

13113 HIGH-ENERGY BEHAVIOR OF BETHE–SALPETER AMPLITUDES: SPIN AND NONPLANAR KERNELS. Brandt, Richard A.; Feinroth, Martin (Univ. of Maryland, College Park). Phys. Rev.; 187: 1888-96(25 Nov 1969).

Previous work on the asymptotic behavior of solutions to the Bethe–Salpeter equation is generalized to include spin and nonplanar kernels. An attempt is made to develop simple heuristic methods for studying the asymptotic behavior of infinite sums of complicated Feynman diagrams. In the simplest case of πN scattering, Regge asymptotic behavior is obtained with explicit formulas for the trajectory functions for a certain class of planar kernels. However, in higher-spin cases like $N\bar{N}$ scattering, the heuristically determined trajectory functions are given by divergent integrals. A modified procedure is developed for this situation, which leads to an asymptotic behavior that is not of the Regge form. The nonplanar X kernel is treated and it is shown how the method leads to the Gribov–Pomeranchuk essential singularity. (auth)

13114 PION–NUCLEON CHARGE-EXCHANGE SCATTERING AND THE CROSSOVER PHENOMENON WITH M = 0 ρ AND M = 1 ρ' TRAJECTORIES. Chu, Shu-yuan (Univ. of California, Riverside); Desai, Bipin R.; Roy, D. P. Contract AT(11-1)-34P107A. Phys. Rev.; 187: 1896-8(25 Nov. 1969).

A Regge-pole model with (M = 0) ρ and (M = 1) ρ' trajectories is used to fit the πN charge-exchange differential cross-section and polarization data. The model automatically predicts the crossover phenomenon around $t = -0.2$ GeV^2 in πN elastic scattering without assuming any zeros in the nonflip ρ residue. Thus it avoids difficulties of such zeros due to factorization. The parameters of the ρ and ρ' are consistent with the nucleon electromagnetic form factors and predict the mass of ρ' to be around 1.1 GeV. (auth)

13115 SUPERCONVERGENT SUM RULES FOR A u = 0 ELASTIC PROCESS. Sharma, M. C.; Seth, V. P.; Agarwal, B. K. (Allahabad Univ., India). Phys. Rev.; 187: 2273-4(25 Nov 1969).

Sum rules were constructed and tested for a u = 0 elastic process $\bar{K} + \Xi \rightarrow \bar{K} + \Xi$ by assuming superconvergent behavior based on a Regge hypothesis and saturation by a finite number of low-lying intermediate states. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 12954, 13423, and 13443.

13116 (INP–682, pp 1-11) REMARKS ON UNITARITY OF VERY HIGH ENERGY SCATTERING AND A SEPARATION OF TWO GROUPS OF DEGREES OF FREEDOM. Czyz, W. (Institute of Nuclear Physics, Krakow (Poland)).

The unitarity relation is analyzed in terms of the Van Hove overlap function. The relation of this model with the spectroscopy of the colliding objects in the case of nuclear scatterings is briefly discussed. It is found that there are two groups of degrees of freedom whose roles are well separated in the limit of very high-energy scattering. (J.F.P.)

13117 (INP–682, pp 12-47) HIGH-ENERGY SCATTERING FROM NUCLEI. Lesniak, L. (Institute of Nuclear Physics, Krakow (Poland)).

Elastic scattering from light, medium, and heavy nuclei including Coulomb interaction effects, the inelastic scattering cross sections and differential scattering cross sections for poor energy resolution are discussed. The analysis shows the consistency of multiple scattering theory with experiments on high-energy elastic and inelastic scattering. (J.F.P.)

13118 (ITF–69-69) COMPARISON OF CONSPIRACY AND CUTS IN NUCLEON–NUCLEON SCATTERING. Kobylinskii, N. A. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 12p. (In Russian). Dep. CFSTI (U. S. Sales Only).

There have been compared two theoretical models of high-energy NN and $N\bar{N}$-scattering, claiming to explain the existence of sharp peaks in differential cross sections of the processes $p + \bar{p} \rightarrow n + \bar{n}$ and $p + n \rightarrow n + p$ near $t = 0$. The model, taking into account both π meson trajectory and cuts, corresponding to simultaneous exchange of π meson and vacuum poles, describes the differential cross section with nonpolarized particles as good as the model which takes into account the contribution of π meson pole and its scalar conspirator. The analysis carried out shows that, on the contrary, these models give different results for polarization of final nucleons. (auth)

13119 RELATIVISTIC TWO-PION-EXCHANGE EFFECTS IN NUCLEON–NUCLEON SCATTERING UP TO 350 MeV. Barker, Bruce M. (Louisiana State Univ., Baton Rouge); Haracz, Richard D. Phys. Rev.; 186: 1624-30(25 Oct 1969).

The two-pion-exchange (TPE) contributions to all of the nucleon-nucleon scattering phase parameters corresponding to values of L between 1 and 5 are presented at the scattering energies from 10 to 350 MeV at intervals of 20 MeV. The phase parameters are derived from the complete fourth-order relativistic scattering matrix, and it is found that the TPE correction to the one-pion-exchange group of phases is large and generally improves the agreement with the phenomenological values. In addition, the effect of the pion mass difference in TPE is tested by calculating the phase parameters at both the neutral- and charged-pion masses. The effect of the nucleon mass difference is tested similarly. (auth)

13120 ELEMENTARY-PARTICLE APPROACH TO SOME NUCLEAR PION REACTIONS. Pascual, P. (CERN, Geneva); Fujii, A. Nuovo Cim.; 65A: 411-20(1 Feb 1970).

An elementary-particle approach is applied to the nuclear pionic pion capture and charge-exchange pion-nucleus scattering under the soft-pion hypothesis. A relation between the muon capture, radiative pion capture and pionic pion capture is discussed. (auth)

13121 ONE-BOSON-EXCHANGE CONTRIBUTIONS WITH FORM FACTORS TO ELASTIC P–P SCATTERING AT HIGH ENERGIES. Hayashi, Hirofumi (Shizuoka Univ., Japan). Progr. Theor. Phys. (Kyoto); 42: 1143-50(Nov 1969).

An analysis of elastic proton-proton scattering at high energies (5 to 30 GeV) is attempted with one-boson-exchange contributions with the form factors $\exp(-A_n s + B_n t + i\varphi_n)$, which are functions of energy, momentum transfer and relative phases. Contributions from only the vector-boson-exchange with vector coupling are conveniently calculated. At least five kinds of vector bosons are needed to make fit to experimental data on both small and large angle scatterings. Parameters are obtained, which give a good fit. The form factors are discussed. The one-pion-exchange contribution is found to be negligible in the high energy region. (auth)

13122 TENSOR FORCES IN THE HYPERTRITON. Buxton, Lawrence Duane. Lexington, Ky.; Univ. of Kentucky (1968). 112p.

Thesis.

The effect of the inclusion of nucleon-nucleon and Λ-nucleon tensor forces in variational calculations on $^3H_\Lambda$ is studied. Only attractive, two-body, Yukawa potentials without hard cores are assumed in this analysis. Triplet and singlet Λ-nucleon potentials are determined which fit $^3H_\Lambda$ and the Λ-p scattering data. The existence of potentials of this type suggests that hard cores may not necessarily be needed in order to obtain agreement between three- and four-body hypernuclei binding energy data and Λ-p scattering data, in contrast to the conclusions of calculations which assumed purely central potentials. The reduction in the central Λ-nucleon strength when a tensor component is included might also help difficulties which exist in $^5He_\Lambda$ and Λ-particle binding in nuclear matter calculations when purely central potentials are assumed. (Diss. Abstr.)

13123 PROJECTION OPERATOR TECHNIQUES FOR SU_3. Noz, Marilyn Eileen. New York; Fordham Univ. (1969). 158p.

Thesis.

Since the proposal of the octet model by Gell'Mann in 1961 much work has been done on the development of the theory of SU_3 and on obtaining its Clebsch–Gordan coefficients and isoscalar factors. A projection operator is developed which acting upon a product state for n particles gives a projection onto a particular IR. The matrix element of the projection operator is obtained and a method of evaluating it using a polynomial formulation is given. Tables of the polynomials are supplied. A theorem which proves that it is only necessary to project onto the one dimensional IR is stated, and this greatly simplifies the procedure. The projection operator is then reformulated and a further simplification is made. The matrix element of the resulting projection operator is obtained, again by a method using a polynomial formulation. Tables of the polynomials are again supplied. It is shown that in this new formulation, it is possible to separate out the I_3 dependence and so obtain a general-

ized formula for the isoscalar factors for SU_3 for a product of n particles. A great simplication occurs when the product is limited to three particles. This is shown in detail. The method is used to obtain certain statistical weights for the p + p interaction. (Diss. Abstr.)

13124 SPIN AND D-STATE EFFECTS ON HIGH-ENERGY ELASTIC SCATTERING OF PIONS ON ^{3}He. Baier, H.; Samaranayake, V. K. (International Centre for Theoretical Physics, Trieste, Italy). Nucl. Phys.; B15: 67-76(1970).

Using Glauber multiple-scattering theory, the spin and D-state effects on elastic π^3He scattering at 0.826 and 2.01 GeV/c small momentum transfer are investigated. Spin effects are shown to be important at the lower energy and the effect of the D-wave component in the ground-state wave function is found to be small, contrary to the deuteron results, where this is conjectured to be the cause of the filling of the dip in the differential cross section. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstract 13195.

13125 (JINR-P2-4845) PARAMETRIZATION OF UNITARY AND STATISTICAL WEIGHT. Mal'tsev, V. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 6p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Projection of an integral state, containing an arbitrary number of octets and decuplets is represented by the integral on parameter space of the symmetry group. (auth)

13126 (SU-1206-212) THE POINCARE GROUP. Lectures by A. P. Balachandran, Goswami, D. N.; Modjtehedzadeh, M. (Syracuse Univ., N. Y. Dept. of Physics). Oct 1969. 77p. (NYO-3399-212). Dep. CFSTI.

The Poincaré group is discussed including the topics the Lie algebra of P, the Lorentz group structure, representation theory of the Poincaré group, the reduction of the direct product, felicity, scalar products, and the Jacob–Wick expansion. (J.F.P.)

Applications (Electromagnetic and Weak)

Refer also to abstract 13362.

13127 MESON MASS SPECTRUM AND THE ALGEBRAIC ASPECTS OF CHIRAL SYMMETRY. Simmons, Walter A. (Univ. of Hawaii, Honolulu). Contract AT(04-3)-511. Phys. Rev.; 186: 1529-31(25 Oct 1969).

The algebraic formalism of chiral SU(2) × SU(2) recently constructed by Weinberg is applied to the spectrum of nonstrange mesons. A mass formula valid under general conditions is derived. It is shown that some semiquantitative features of the formalism are in good agreement, both with existing data, and with current ideas about mass spectra such as rising Regge trajectories, meson towers, and the Veneziano representation. An attempt to fit known mesons into a coherent supermultiplet structure is described. Some arguments are given as to why this will probably not be possible without further assumptions. It is argued that if the theory is to be useful, it must be cast into a stronger form in which SU(2) × SU(2) is an approximate symmetry of the spectrum. (auth)

13128 K_{l4} FORM FACTORS AND THE BREAKING OF CHIRAL SYMMETRY. Gaillard, M. K. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nuovo Cim.; 65A: 135-52(1 Jan 1970).

K_{l4} form factors are studied under the assumption that chiral $SU_3 \otimes SU_3$ is broken by a term in the Hamiltonian which transforms according to the representation $(3,\bar{3}) + (\bar{3},3)$. If the symmetry breaking is not such that an approximate $SU_2 \otimes SU_2$ invariance is retained, soft-pion predictions obtained from matrix elements of currents differ from those obtained using matrix elements of the divergences. It is argued that in this case the soft-pion limits of the divergence matrix elements give a better approximation to the physical amplitudes. Deviations from standard current-algebra predictions in K_{l4} decay can then be related to deviations in K_{l3} decay (i.e., a large ξ value). If ξ is large and negative ($\xi \approx -0.5$), K_{l4} decay rates are predicted to be considerably higher than those found with the standard soft-pion techniques. (auth)

13129 THE GLASHOW–WEINBERG MODEL FOR $SU_3 \times SU_3$ SYMMETRY BREAKING. Cleymans J. (Univ. Catholique, Louvain, France). Nuovo Cim.; 65A: 72-8(1 Jan 1970).

It is shown that the disturbing features of the Glashow-Weinberg model for breaking $SU_3 \otimes SU_3$ symmetry, namely the inequality $m_\kappa \leq 670$ MeV and the value $f_+(0) = 0.85$, disappear if instead of the first Weinberg sum rule, the "broken" spectral sum rules proposed by Sugawara are used. These sum rules are based on mass mixing in the Lagrangian of the algebra of fields. Taking $F_K/F_\pi f_+(0) = 1.22$, the Glashow-Weinberg limit is relaxed and only $m_\kappa \leq 1428$ MeV is needed. Furthermore $f_+(0) = 0.97$. For $m_\kappa = 1080$, 1100, 1160 and 1200 MeV the Gell-Mann symmetry-breaking parameter c equals −1.25, −1.23, −1.21 and −1.1 respectively. (auth)

13130 THREE-PION DECAYS OF THE SHORT-LIVED KOAN. Chela-Flores, J.; Colegrave, R. K. (Chelsea Coll., London). Nuovo Cim.; 65A: 79-88(1 Jan 1970).

The methods of the generalized parametrization are extended in order to study the η_{+-0} and η_{000} parameters. (auth)

13131 BROKEN SU(3) ⊗ SU(3) WITH THE $\varkappa$-MESON FIELD ALGEBRA AND THE SUGAWARA MODEL. Burnel, A. (Univ., Liege). Nucl. Phys.; B15: 146-56(1970).

A general scheme for the description of broken SU(3) ⊗ SU(3) in the framework of field algebra is extended in order to include, first, the Sugawara model and, second, the contribution of the κ-meson. The Sugawara model is shown to be incompatible with the $(3,\bar{3}) \oplus (3,3)$ breaking of SU(3) ⊗ SU(3), while the κ-meson is introduced in such a way that it alters nothing but the ratio F_K/F_π. (auth)

13132 CALCULATION OF Reϵ FOR THE $K^0-\bar{K}^0$ SYSTEM. Kamal, A. N.; Kenny, B. G. (Rutherford High-Energy Lab., Chilton, Eng.). Phys. Rev.; 186: 1473-6(25 Oct 1969).

An attempt is made to estimate the contribution to Reϵ for the $K^0-\bar{K}^0$ system from the existence of CP nonconservation in the $|\Delta I| > \frac{1}{2}$ $K^0 \to 2\pi$ amplitude. In doing so, three parametrizations of the S-wave I = 2 π-π scattering phase shift δ_2. These, in turn, were used to calculate the self-energy contribution to the complex-mass matrix for the $K^0-\bar{K}^0$ system. It is found that the contribution of the above amplitude to Reϵ, although an order of magnitude larger than previous estimates by Truong and Barshay, is smaller than experimental measurements of Reϵ by at least a factor of 2. (auth)

13133 WEAK-INTERACTION THEORIES OF CP NONCONSERVATION APPLIED TO HYPERON NONLEPTONIC DECAY. Albright, Carl H. (Northern Illinois Univ., DeKalb). Phys. Rev.; 187: 1880-7(25 Nov 1969).

Possible CP violation in hyperon nonleptonic decay is investigated in the framework of several current-current weak-interaction theories which have recently been proposed. Of those studied, only the neutral-current models of Das and Oakes lead to unambiguous results. The Das model is extraordinary in that it predicts a maximal CP violation in the Σ^+_+ decay mode which, unfortunately, the final-state interactions conspire to imitate even if CP is conserved. This same model suggests a CP-violating effect in the Σ^-_- mode, which is roughly a 2° departure from the final-state-interaction correction of 7° to Δ. (auth)

13134 MASS RELATIONS FOR MIXED SU(3) SUPERMULTIPLETS. Gomberoff, L.; Tolmachev, V. (Univ. of Chile, Santiago). Phys. Rev.; 187: 2185-8(25 Nov 1969).

It is shown that mixing among SU(3) supermultiplets leads to new mass relations. These mass relations could be useful for the interpretation of some experiments and for further particle assignments to SU(3) supermultiplets. In this context, some possibilities are discussed for the $\frac{5}{2}^-$, $\frac{3}{2}^+$ baryons and 1^+ mesons. (auth)

Applications (Strong)

Refer also to abstract 13106.

13135 REGGEIZATION IN SUPERMULTIPLET THEORIES. Delbourgo, R.; Salam, Abdus (International Atomic Energy Agency, Trieste, Italy). Phys. Rev.; 186: 1516-28(25 Oct 1969).

Methods for incorporating higher-symmetry ideas into the phenomenology of Regge poles are reviewed. The methods, which were developed originally for treating models of the "quark-excitation" type, are extended to cover also the "orbital excitation" models with particular reference to the oscillator model. (auth)

13136 BROKEN-SYMMETRY COUPLINGS FOR $S_3 \to P_8P_8$. Tze, Hsiung Chia (Univ. of Chicago). Phys. Rev.; 186: 1470-3 (25 Oct 1969).

The existence of an isosinglet η'(1070 MeV) and an isotriplet π'(1016 MeV) of a presumed scalar octet has been established recently. A simple model, essentially combining a set of triangle Feynman graphs and the Gell-Mann–Okubo mass formula, allows the calculation of the broken-symmetry coupling constants for $S_8 \to P_8P_8$. In particular, the anomalous value observed in the branching ratio $R_\eta(\pi\pi/K\bar{K})$ is accounted for. (auth)

13137 PARTICLE MIXING FROM SPONTANEOUS SYMMETRY BREAKDOWN. Cicogna, G. (Univ., Pisa, Italy); Caffarelli, R. Vergara. Nuovo Cim.; 65A: 89-98(1 Jan 1970).

The occurrence of particle mixing as a consequence of spontaneous symmetry breakdown is investigated, and the general conditions which can lead to the mixing are given. The particular case of ω-φ mixing is considered in detail; it is shown that, under very general hypotheses, spontaneous breakdown gives rise to this mixing with an angle θ satisfying $\cos\theta = (\frac{2}{3})^{\frac{1}{2}}$. (auth)

13138 CURRENT ALGEBRA AND POLE DOMINATED AAV VERTEX. Gado, J.; Montvay, I. (Roland Eoetvoes Univ., Budapest). Nucl. Phys.; B15: 316-22(1970).

An axial vector-axial vector-vector (AAV) three-point functions are investigated for arbitrary SU(3) indices without imposing SU(3) symmetry. The predictions of gauge field algebra for meson decays and form factors are compared with present experimental data using the assumption of pole dominance. The results suggest the current-mixing model for ω-ϕ mixing. (auth)

13139 BROKEN CHIRAL SYMMETRIES, ALGEBRA OF FIELDS, AND SPECTRAL-FUNCTION SUM RULES. Burnel, A. (Univ., Liege). Nucl. Phys.; B15: 17-34(1970).

Chiral SU(2) ⊗ SU(2) and SU(3) ⊗ SU(3) symmetries are investigated in the framework of the algebra of fields and of the effective Lagrangians. The breaking of these symmetries is introduced quite generally by replacing in the symmetric Lagrangian equal masses and coupling constants by different ones in such a way that current algebra is satisfied. The first Weinberg sum rule, a modified form of the second one as well as a sum rule relating the spin one and spin zero spectral functions are obtained. Moreover, a relation between 1^+ and 1^- meson mass ratios is derived. The Weinberg mass relation is obtained when the pion is not massless and the D- and E-meson masses are estimated. (auth)

Field Theories

General

Refer also to abstract 12378.

Quantum Field Theory

Refer also to abstracts 13105, 13197, and 13204.

13140 (CONF-670203-(Vol.1)) PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON LOW AND INTERMEDIATE ENERGY ELECTROMAGNETIC INTERACTIONS, DUBNA, FEBRUARY 7–15, 1967. (Akademiya Nauk SSSR). 1967. 163p. (In Russian and English).

The seven papers presented give a general review on quantum electrodynamics. Also problems of electromagnetic interactions at low and medium energies and electromagnetic properties of particles are discussed considering fundamental interactions of photon-nucleons including the photo- and electroproduction of mesons, and electron and photon scattering on nucleons. Photon and electron interactions with a group of nucleons including photo- and electroproduction of mesons on nuclei and photo- and electro-spallation of nuclei are treated. (R.V.J.)

13141 (JINR-P2-4812) TWO-POINT FUNCTIONS FOR LOCAL INFINITE-COMPONENT FIELDS. Oksak, A. I.; Todorov, I. T. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 47p. (In Russian). Dep. CFSTI (U. S. Sales Only).

A two-point function of local infinite-component fields ϕ and ψ transforming under arbitrary irreducible representations χ_1 and χ_2 of the proper Lorentz group is studied by the manifestly covariant technique. A generalized version of the Grodsky–Streater theorem on the infinite degeneracy of mass with spin in the infinite-component field theory is proved. (auth)

13142 PROPAGATION AND QUANTIZATION OF RARITA-SCHWINGER WAVES IN AN EXTERNAL ELECTROMAGNETIC POTENTIAL. Velo, Giorgio; Zwanziger, Daniel (New York Univ., N. Y.). Phys. Rev.; 186: 1337-41(25 Oct 1969).

The Rarita–Schwinger equation in an external electromagnetic potential is shown to be equivalent to a hyperbolic system of partial differential equations supplemented by initial conditions. The wave fronts of the classical solutions are calculated and are found to propagate faster than light. Nevertheless, for sufficiently weak external potentials, a consistent quantum mechanics and quantum field theory may be established. These, however, violate the postulates of special relativity. (auth)

13143 REGGE POLES IN SCALAR-VECTOR FIELD THEORY. Shapero, Don (Massachusetts Inst. of Tech., Cambridge). Phys. Rev.; 186: 1697-1700(25 Oct 1969). Contract AT(30-1)-2098.

It is shown that to fourth order, the asympotic behavior of the photon-meson helicity amplitudes in scalar electrodynamics may be viewed as arising from two nearby Regge poles. The photon-meson scattering amplitude is examined to fourth order in the limit $(-z) \to \infty$, where z is the cosine of the scattering angle. The two highest powers of $\ln(-z)$ are retained. By comparing these forms order by order with those predicted by the presence of two Regge poles, two trajectories are obtained, one of which passes through the meson. (auth)

13144 INFINITE-MOMENTUM LIMIT OF A SPINOR FIELD THEORY. Flory, David (Yeshiva Univ., New York). Phys. Rev.; 186: 1701-3(25 Oct 1969).

Weinberg has shown that in an infinite-momentum frame moving along the $-z$ axis, the old-fashioned perturbation-theory graphs containing intermediate particles with negative p_z vanish. This result is here extended to a theory of spin-$\frac{1}{2}$ and scalar or pseudoscalar particles with a $g\bar{\psi}\Gamma\psi\varphi$ interaction ($\Gamma = 1$ or γ^5) in a tree-graph approximation. The effect of the particles with negative p_z is absorbed into a counterterm in the Hamiltonian. This counterterm is of order g^2 in the coupling constant. (auth)

13145 JOST-FUNCTION DESCRIPTION FOR THE BETHE–SALPETER EQUATION. Haymaker, Richard W.; Blankenbecler, R. (Univ. of California, Santa Barbara). Phys. Rev.; 186: 1648-55(25 Oct 1969).

A new formulation of the Bethe–Salpeter eigenvalue problem is presented. An integral representation of the eigenvalue condition is given which is a generalization of the familiar Jost function in nonrelativistic theory. The formalism is worked out in detail for the scalar-exchange potential and is used to examine Regge trajectories in the weak coupling limit. The detailed multiplicity of the lower trajectories is shown to depend on the behavior of the potential at the origin in coordinate space, and hence to be very potential-dependent. (auth)

13146 INDEFINITE METRIC IN MASSLESS QUANTUM FIELD THEORIES OF ARBITRARY SPIN. Duerr, H. P.; Rudolph, E. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nuovo Cim.; 65A: 423-66(1 Feb 1970).

The Gupta–Bleuler quantization procedure of electrodynamics is generalized to massless quantum field theories of higher spin without interaction, in particular to include the linearized form of a quantized gravitational theory. It is shown that a manifest Lorentz-invariant local formulation of a theory for spin-j massless particles requires in general the introduction of $2(j^2 + 1)$ field components which transform under a reducible representation of the homogeneous Lorentz group and are linear operators in a state space with an indefinite metric. Using the spinor representation rather than the usual tensor representation the operators in momentum space can be easily subdivided into the two physical operators connected with the annihilation and creation of the two physical mass-zero modes and $2j^2$ ghost operators which can be arranged into j^2 pairs. Each operator pair is connected with annihilation and creation of two nonorthogonal norm-zero states, a "good" and a "bad" ghost. A physical interpretation of the theory is achieved by projection on a physical state space with positive semi-definite metric which consists in the invariant elimination of all j^2 bad ghosts by j^2 Gupta-type conditions. The physical unobservable admixture of the j^2 good ghosts reflects the gauge degrees of freedom of equal dimension. (auth)

13147 PRINCIPLE OF ACTION WITH HIGHER DERIVATIVES. Borneas, M. (Polytechnic Inst., Timisbara, Rumania). Phys. Rev.; 186: 1299-1303(25 Oct 1969).

The general formalism of a theory with higher derivatives is developed, starting from the action principle with inclusion of the variations at the boundary. The domain of mechanics is examined first, then that of field theory. In both cases the equations of motion (field) are derived, then conservation laws for known and new magnitudes are established. (auth)

13148 EIKONAL APPROXIMATION IN QUANTUM FIELD THEORY. Levy, Maurice; Sucher, Joseph (Univ. of Maryland, College Park). Phys. Rev.; 186: 1656-70(25 Oct 1969).

The eikonal approximation for high-energy collisions, long familiar in the theory of potential scattering, is considered from the viewpoint of relativistic quantum field theory. In particular, the Feynman amplitude M(s,t) describing the scattering of two spin-0 particles, a and b, interacting by the exchange of spin-0 mesons is studied. It is shown that if $M_n(s,t)$, the contribution to M(s,t) arising from all nth-order Feynman diagrams in which exactly n mesons are exchanged between a and b, is written in an appropriately symmetrized way, and if the terms in any a or b particle propagator which are quadratic in the internal momenta are then dropped, the resulting expression, $M_n^{eik}(s,t)$, may be evaluated in closed form, and the sum over n, which defines $M^{eik}(s,t)$, may be carried out. The representation of $M^{eik}(s,t)$ found in this way involves the exponential of a function χ of a relative space-time variable $x = (x^0,x)$ and the external momenta; χ is a relativistic generalization of the eikonal χ_{pot} familiar from the theory of high-energy potential scattering. $M^{eik}(s,t)$ is both crossing-symmetric and time-reversal-invariant. In the static limit ($m_b \to \infty$), χ tends to χ_{pot} for the appropriate Yukawa potential and $f^{eik} = -M^{eik}/8\pi\sqrt{s}$ has a limiting form f_{pot}^{eik}, which is also derived directly from the theory of potential scattering; for small scattering angles, f_{pot}^{eik} coincides with the standard result. The amplitude for particle-antiparticle scattering is studied in the same model. It is shown that the eikonal $\chi_2(x)$ associated with the contribution of all annihilation-type diagrams has a logarithmic singularity at $x = 0$ whose coefficient is proportional to $\alpha(t) + 1$, where $\alpha(t)$ is the Regge-trajectory function obtained from the asymptotic behavior of the ladder-type diagrams alone. Another connection with Regge behavior is made by showing that the summation of a certain infinite class of radiative corrections to the lowest-order γ-e Compton amplitude gives rise, in our eikonal approximation, to an eikonal $\chi(x)$ which has a similar logarithmic singularity with strength $1 + \beta(t)$; here $\beta(t)$ is a trajectory function, introduced less directly in earlier work, which reproduces the major part of the spectrum of positronium on setting $\beta(t) = l = n - 1$. A generalization of a simple algebraic identity used in the derivation of the above results, in the form of an integral representation, permits their extension to the case where one or more particles are off the mass shell. This is illustrated by a computation of an eikonal-type approximation to the Green's function for a relativistic particle moving in an external scalar field and by the summation of an infinite class of contributions to the vertex function in the model referred to above. The possibility of applying an off-shell eikonal approximation to the analysis of production processes is emphasized. (auth)

13149 CONSISTENCY OF CANONICAL QUANTIZATION IN THE CASE OF NONCONSERVED CURRENTS. Kimura, T. (Hiroshima Univ.); Senba, K. Lett. Nuovo Cim.; 2: 752-5 (1 Dec 1969).

It is shown that a previous inconsistency of the canonical formalism with the exact solution of the field equations when the vector field is coupled to a nonconserved current does not appear if the correct canonical formalism is used and the correct two-point functions related to the exact solution of field equations are taken. The consistency of the equal-time commutator of fields is verified from various points. It is shown that the canonical quantization of fields does not lead to inconsistency even if the current is not conserved. (J.F.P.)

13150 COMMENTS ON NONCLASSICAL GENERAL COVARIANCE AND COMPLEMENTARITY. Saleem, M. (Panjab Univ., Lahore). Lett. Nuovo Cim.; 2: 756-7(1 Dec 1969).

It is shown that a previous assertion that the principle of general covariance does have physical significance in the domain of quantum physics and combined with other assumptions leads to commutation relations for noncomplementary variables such as the space–time coordinates is not correct. It is asserted that the general covariance principle leads to physical predictions neither in classical physics nor in quantum physics. (J.F.P.)

13151 AXIAL-CURRENT WARD-TAKAHASHI IDENTITIES. Amati, D.; Bouchiat, C.; Gervais, J. L. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nuovo Cim.; 65A: 55-71(1 Jan 1970).

Using a gauge-invariant regularization technique involving regulator fields quantized with the wrong statistics, a general analysis is given of the anomalous properties of the axial-current divergence in the presence of external non-Abelian gauge vector fields. The anomaly in the Ward-Takahashi identities appears as the regulator contribution to the matrix element of the axial-current divergence, in the limit of infinite regulator mass. In some instances the limit is finite and independent of the detail of the regularization procedure, but in the other ones the limit is infinite. The breakdown of the PCAC relation in the presence of vector fields is discussed in the framework of the regularized σ model. It is shown that the physical implications of PCAC (for instance the Goldberger-Treiman relation), would be jeopardized in a theory with strongly coupled canonical vector fields as the field algebra scheme. (auth)

13152 CALCULATION OF THE TRANSITION MATRIX OF THE WICK–CUTKOSKY MODEL. zur Linden, E. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nuovo Cim.; 65A: 197-204(1 Jan 1970).

The inhomogeneous Bethe-Salpeter equation for the transition matrix of the Wick-Cutkosky model is solved. The solution is represented in various forms. Some properties of the transition matrix are investigated. (auth)

13153 COVARIANT VERTEX FOR NONRELATIVISTIC BOUND STATES. Bisiacchi, G. (Univ., Trieste, Italy); Budini, P.; Calucci, G. Nuovo Cim.; 65A: 1-11(1 Jan 1970).

The covariant description of the center-of-mass motion for a composite system with nonrelativistic internal motion is given, together with the vertex for its interaction with an external field. For low momentum transfer an expression for the vertex in terms of three-dimensional wave functions, which includes relativistic effects, is deduced. At high momentum transfer, retardation effects inside the composite structure must be taken into account. The algebrization of the equation for the free motion is given and that for the vertex discussed. (auth)

13154 GENERALIZED HELICITY METHOD FOR FEYNMAN DIAGRAM CALCULATIONS. Kessler, Paul (College de France, Paris). Nucl. Phys.; B15: 253-66(1970).

A calculation method is presented here, based upon a four-dimensional generalization of helicity, which allows to achieve considerable simplifications in calculations of Feynman diagrams of the "chain" type (without closed loops). (auth)

13155 ANOMALOUS COMMUTATORS AND THE BOX DIAGRAM. Boulware, David G. (Univ. of Washington, Seattle); Jackiw, R. Phys. Rev.; 186: 1442-8(25 Oct 1969).

In continuation of previous investigations, commutator anomalies associated with the box diagram are exhibited. It is found that q-number Schwinger terms are present in the general case for commutators of currents which are bilinear in fermion fields. Nevertheless, the Weinberg sum rule is not violated. A c-number Schwinger term, which involves three derivatives at a δ function, is also found. (auth)

13156 THE ELECTRON–POSITRON FIELD, COUPLED TO EXTERNAL ELECTROMAGNETIC POTENTIALS, AS AN ELEMENTARY C* ALGEBRA THEORY. Bongaarts, P. J. M. (Massachusetts Inst. of Tech., Cambridge). Ann. Phys. (N. Y.); 56: 108-39(Jan 1970).

In recent years C* algegra concepts have been suggested for dealing rigorously with the mathematical difficulties of quantum field theory. To demonstrate some of the possibilities of these concepts an explicit and completely rigorous C* algebra treatment of the simple model of the electron-positron field interacting with an external, classical electromagnetic field is presented. The usual results, most of which cannot be derived in a rigorous way within the ordinary Fock–Hilbert space formalism, are obtained here in a straightforward and mathematically unobjectionable manner, in which divergent or ill-defined expressions are absent. In particular no readjustments because of vacuum contributions have to be made in the resulting S operator and the terms of its perturbation series. (auth)

13157 RENORMALIZEABILITY OF MASSIVE NON-ABELIAN GAUGE FIELDS: A FUNCTIONAL INTEGRAL APPROACH. Boulware, David G. (Univ. of Washington, Seattle). Contract AT(45-1)-1388B. Ann. Phys. (N. Y.); 56: 140-71(Jan 1970).

The renormalizability of massive non-Abelian vector gauge fields is discussed using a functional integral technique. The ideas are first developed for the case of a neutral vector meson coupled to a conserved current, where the renormalizability holds. The non-Abelian vector field is written as the gauge transform of a four-dimensionally transverse field, and the transverse and gauge variables are then treated separately. It is shown that the renormalizability depends solely on that of the gauge variables, which are found to be nonrenormalizable; hence, neither is the field theory. The gauge variables alone provide a representation of the σ-model and of Sugawara's theory of currents, which are thus shown to be nonrenormalizable theories. (auth)

13158 PERTURBATION THEORY AND SELF-MASS INSERTIONS. Brown, Lowell S. (Univ. of Washington, Seattle). Contract AT(45-1)-1388. Phys. Rev.; 187: 2260-5(25 Nov 1969).

First-order perturbation corrections to strong-interaction amplitudes are considered in the context of quantum field theory.

It is shown that such corrections may be expressed entirely in terms of on-mass-shell matrix elements of the unperturbed system, matrix elements which are evaluated at the unperturbed mass. The general method is illustrated by a detailed discussion of form-factor corrections. In particular, the method is applied to the conserved-vector form factor of a meson multiplet, and it is shown that the Ademollo–Gatto theorem holds only if the perturbation is local. The violation of this theorem, which occurs in the electromagnetic correction to pion β decay, is discussed. (auth)

13159 NUMERICAL SOLUTIONS OF THE BETHE–SALPETER EQUATION. Kaufmann, William B. (Univ. of California, Berkeley). Phys. Rev.; 187: 2051-75(25 Nov 1969).

After summarizing the application of the Rayleigh–Ritz and Schwinger variational principles to the unequal-mass ϕ^3 Bethe–Salpeter equation, the solution of the bound-state problem is presented in graphical and tabular form. The dependence of the coupling-parameter eigenvalue on the exchange mass, external mass ratio, and binding energy is examined in detail for s and p ground states. Mixing of excited levels leading to complex solutions is briefly studied, and some Regge trajectories are also calculated. Scattering phase shifts for unequal-mass scattering were calculated and representative examples are given. The fact that certain levels do not appear to contribute to Levinson's theorem is also examined. Finally, the foregoing methods are generalized to two-channel systems, and channel phase shifts and inelasticities are computed. (auth)

13160 SOME ASPECTS OF FIELD SYMMETRIES. II. Scharfstein, H. Phys. Rev.; 187: 2027-39(25 Nov 1969).

The consideration of representations of operators satisfying trilinear equal-time commutation relations and their possible physical relevance is continued. A representation previously studied, when modified to some extent, yields an improved correspondence between the operators of the representation and physical particles. Several schemes of associating operators with particles are considered. The representations raise the possibility of partially eliminating some divergences. In an approximation in which spin-1 and higher-spin resonances are disregarded, the requirement that the lowest-order self-energy corrections to the propagators of spin-$\frac{1}{2}$ baryons be finite implies a set of relations between the coupling constants and mass ratios of the particles concerned. (auth)

13161 CHIRAL-INVARIANT REGULARIZATION AND RENORMALIZATION OF THE AXIAL-VECTOR CURRENT. Kim, C. W.; Repko, W. W.; Sato, A. (Johns Hopkins Univ., Baltimore). Phys. Rev.; 187: 1966-74(25 Nov 1969).

The regularization and renormalization procedures for perturbation calculations involving the axial-vector current of the σ model are considered. It is shown that, even in the absence of electromagnetism, special care must be exercised when introducing fermion regulator fields into the Lagrangian so that the axial-vector Ward–Takahashi identity is not violated in the process. A generalized method of regularization is proposed in which the regulator part of the Lagrangian satisfies chiral invariance and which reduces to the usual one when applied to quantities other than the axial-vector current. By virtue of the chiral-invariant character of this method, a subtraction procedure can be introduced for the axial-vector vertex which eliminates unrenormalizable cutoff-dependent terms. After this subtraction, the regularized axial-vector vertex of the σ model satisfies the usual Ward–Takahashi identity and is renormalizable by rescaling of the external wave functions. (auth)

13162 INFINITIES OF NONLINEAR AND LAGRANGIAN THEORIES. Delbourgo, R.; Salam, Abdus; Strathdee, J. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev.; 187: 1999-2007(25 Nov 1969).

The technique for summing perturbation contributions introduced by Efimov and Fradkin is extended and applied to nonlinear (chiral) Lagrangian theories. It is shown that the only likely infinities in these theories are those associated with self-mass and self-charge. (auth)

13163 LAGRANGIAN FORMS OF THE DYNAMICAL THEORY OF CURRENTS. Deser, S. (Brandeis Univ., Waltham, Mass.). Phys. Rev.; 187: 1931-4(25 Nov 1969).

Simple Lagrangian formulations of Sugawara models are given, which directly exhibit the "gauge-component" nature of the currents. It is also shown that there is no corresponding theory for tensor currents. (auth)

13164 GENERALIZATIONS OF THE SUGAWARA MODEL. Deser, S.; Rawls, J. (Brandeis Univ., Waltham, Mass.). Phys. Rev.; 187: 1935-9(25 Nov 1969).

Two generalizations of Sugawara models are discussed. In the first, new interactions are introduced by altering the current commutators but retaining the "free" form of $T_{\mu\nu}$, as exemplified by a simple effective $\pi^0-2\gamma$ interaction, which is compared with the standard triangle-diagram results. The second permits nonquadratic $T_{\mu\nu}$ which retain the "algebra" part of the current commutators; these models avoid the Dashen–Frishman parity degeneracy. (auth)

Gravitation and General Relativity

Refer also to abstract 12621.

13165 (ITF-69-61) EXACT CONFORMALLY-PLANE SOLUTION OF THE EINSTEIN EQUATIONS FOR THE NON-STATIC AXIAL FIELD SYMMETRY. Bondarenko, N. P.; Kobushkin, P. K. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 31p. Dep. CFSTI (U. S. Sales Only).

The exact solution of the equations of the general theory of relativity for the case of the conformally plane field of the non-static axial symmetry is found in the work. It is shown that the obtained equation: can describe the metric of the non-static anisotropic material model with the homogeneous distribution of matter and the inhomogeneous distribution of pressure, allows the possibility of the oscillations with the existence of the regular minimum of "radius" of the corresponding model, in the limiting case the solution describes the non-static cosmological Einstein–Sitter's model. Axial character of the model is connected with the postulated density of the field angular momentum. (auth)

13166 INTRINSIC CAUCHY PROBLEM IN GENERAL RELATIVITY. Choquet-Bruhat, Yvonne; Geroch, Robert (Institut Henri Poincare, Paris. Syracuse Univ., N. Y.). Compt. Rend., Ser. A; 269: 746-8(20 Oct 1969). (In French).

An expression of the intrinsic Cauchy problem in general relativity is given, an existence and local uniqueness theorem is shown, supported by previously obtained results but allowing a purely geometrical formulation in terms of initial variety (of dimension 3) and tensors on this variety. (J.F.P.)

13167 A GRAVITATIONAL THEORY OF THE μ-MESON AND LEPTONS IN GENERAL. Motz, L. (Columbia Univ., N. Y.). Nuovo Cim; 65A: 326-32(21 Jan 1970).

A gravitational theory of leptons is proposed in which the mass of the electron and that of the muon are the roots of a simple quadratic equation. This equation is obtained from the Reissner–Weyl metric for a charged particle by assuming that the gravitational constant suffers a sharp discontinuity at the surface of a particle, and by imposing the condition that $dr/dt = 0$ along the null line $ds = 0$. (auth)

13168 COMMENTS ON EINSTEIN SCALAR SOLUTIONS. Janis, Allen I. (Univ. of Pittsburgh); Robinson, David C.; Winicour, Jeffrey. Phys. Rev.; 186: 1729-30(25 Oct 1969).

Simple solutions of the Einstein scalar and Brans–Dicke field equations are exhibited, and the nature of the Killing horizons of some static solutions is discussed. (auth)

13169 QUANTUM COSMOLOGY. I. Misner, Charles W. (Univ. of Maryland, College Park). Phys. Rev.; 186: 1319-28 (25 Oct 1969).

The Hamiltonian methods of Arnowitt, Deser, and Misner can be applied to homogeneous cosmological models and prove to be an efficient way both of constructing the Einstein equations and of studying their solutions. By using an appropriate form for the metric, one finds that the constraint equations for these models can be solved explicitly, and the resulting problem in Hamiltonian mechanics resembles that of a particle in a potential well. The most unusual feature of the Hamiltonian is that it is explicitly time dependent. There is an easy and attractive choice of factor orderings which allows one to pass on to a quantum theory (by imposing canonical commutation relations on the independent canonical variables) while maintaining the signature of the quantized metric. For the closed-space cosmological model (Bianchi type IX) which is studied in most detail, a classical (high-quantum-number) state remains classical as the wave function is followed back in time toward the initial singularity. There is no tendency for significant contributions from states of low quantum number to develop even when the radius of the universe is much less than $(G\hbar/c^3)^{1/2} = 10^{-33}$ cm. (auth)

13170 GRAVITATIONAL FIELD OF A SPHERE COMPOSED OF CONCENTRIC SHELLS. Mehra, A. L. (Jodhpur Polytechnic, India); Vaidya, P. C.; Kushwaha, R. S. Phys. Rev.; 186: 1333-4 (25 Oct 1969).

A general solution of the field equations of general relativity

theory has been obtained for a composite sphere having a number of shells, one above the other, of different densities. (auth)

13171 A NEW LINEAR THEORY OF GRAVITATION. II. Gottlieb, I.; Mociutchi, C.; Segal, A.; Tatomir, D.; Teodorescu, V. An. Stiint. Univ. Al. I. Cuza Iasi, Sect. Ib. Fiz.; 14: 5-8(1968). (In German).

A previous study is resumed by extending it to the theory of the free gravific field. The equations of the free gravific field are developed together with the expressions of the energy canonic and metric tensor and of the symmetrization tensor leading to the spin density tensor of the gravific field. The gravific field tensor is not determined univocally, but the univocal character of the solutions is ensured by some additional conditions, finally yielding the equation of continuity. (Rom. Sci. Abstr.)

13172 BACK REFLECTION OF SCALAR AND VECTOR WAVES IN GRAVITATIONAL FIELDS. Nordtvedt, K. Jr. (Montana State Univ., Bozeman). Phys. Rev.; 186: 1352-4(25 Oct 1969).

The back reflection of mass-zero scalar or vector waves passing through a gravitational field is calculated. In the Newtonian (equivalence-principle) approximation to Einstein's or Brans and Dicke's gravitational theory, no back reflection occurs. The non-Lorentz part of the spatial metric components ($g_{xx}g_{yy}g_{zz}$) produce the back reflection of the waves. For optimum wavelengths, the reflection coefficient of a wave passing a mass M at distance d is of order GM/c^2d. (auth)

13173 FIELD OF AN ARBITRARILY ACCELERATING POINT MASS. Kinnersley, William (Univ. of Texas, Austin). Phys. Rev.; 186: 1335-6(25 Oct 1969).

A metric of the Kerr–Schild type is derived which contains four arbitrary functions of time. It is a generalization of Vaidya's shining-star metric, and permits arbitrary acceleration of the source. (auth)

13174 ABSOLUTE ZERO OF TIME. Misner, Charles W. (Univ. of Maryland, College Park). Phys. Rev.; 186: 1328-33 (25 Oct 1969).

A singularity involving infinite densities at a finite proper time in the past is strongly suggested for the beginnings of the Universe by Einstein's general relativity theory, and is consistent with the few relevant observational data. There is no reasonable point at which to anticipate a failure of the theory, especially since a simplified quantum calculation in the accompanying paper predicts that quantum effects do not change the nature of the singularity. Therefore, it is suggested that the singularity be treated as an essential element of cosmological theory, and indicate how this can be made more palatable by refining our concepts of time. (auth)

13175 DIVERGENCE OF AXIAL-VECTOR CURRENT IN THE GRAVITATIONAL FIELD. Kimura, Toshiei (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 42: 1191-1205(Nov 1969).

To clarify the similarity and dissimilarity between the electromagnetic and gravitational fields, the vacuum expectation value of the divergence of the axial-vector current is evaluated in the external gravitational field. Within the framework of the perturbation approach in the Minkowski space, the requirement of gauge invariance yields the finite extra term in addition to the expected term. The additional term comes from the diagrams of the triangle closed loop and the two-sided closed loop which is linked to the former to maintain gauge invariance. Within the covariant formalism in the Riemannian space-time, it is also examined whether the additional term can be inferred directly from the field equations by giving a proper definition of the operator of the axial-vector current. To maintain gauge invariance explicitly, the spinor fields in the current are separated infinitesimally and are parallel-transported back. A difficulty lies in defining the correct current which gives the same additional term as given by the perturbation treatment in the Minkowski space. The origin of the difficulty is discussed in connection with the nonlocal nature of the gravity. (auth)

13176 CONTINUOUS GEOMETRY OF A RELATIVISTIC THEORY OF ELECTROMAGNETIC AND GRAVITATIONAL FIELDS. Droz-Vincent, Philippe (Institut Henri Poincare, Paris). Compt. Rend., Ser. A; 269: 682-4(13 Oct 1969). (In French).

The infinitesimal structure is studied, which appears in electromagnetic and gravitational space–time in the previously unified Rainich theory. (tr-auth)

13177 INTERPRETATION OF A UNIFIED THEORY OF GRAVITATION AND SYMMETRY BREAKING. Peak, David; Inomata, Akira (State Univ. of New York, Albany). Phys. Rev.; 187: 2276-7(25 Nov 1969).

The formalism of Moen and Moffat is interpreted as a Yang–Mills theory set in a space-time generally endowed with curvature and torsion. (auth)

13178 MOTION AND STRUCTURE OF SINGULARITIES IN GENERAL RELATIVITY. Newman, E. T.; Posadas, R. (Univ. of Pittsburgh). Phys. Rev.; 187: 1784-91(25 Nov 1969).

A new approach to equations of motion in general relativity is presented. Unlike the usual approaches, which rely on a regular background, this approach, by means of the method of spin coefficients, is based on the properties of the null cones emanating from a singular world line. It is applied to the Robinson–Trautman metrics as well as to their charged counterparts, and exact equations of motion are obtained that give an intrinsic description of the behavior of a singularity in its own space-time. Two results of this approach are the discovery of an internal structure for a singularity and the surprising appearance of the Abraham radiation-reaction term in the charged case. (auth)

13179 GRAVITATIONAL RADIATION INTERACTION BETWEEN TWO SEPARATED SYSTEMS. Cooperstock, Fred I.; Booth, Dexter J. (Univ. of Victoria, British Columbia). Phys. Rev.; 187: 1796-1802(25 Nov 1969).

Einstein's power-transfer theory is developed to exhibit the rate at which energy is transferred by gravitational radiation from an emitter to an absorber in terms of their lowest-order contributing multipole moments (quadrupole), the separation distance, and the emitter frequency. The description of the interaction is complete, and the need to calculate fields is obviated. Consistency is demonstrated by comparing the total power transferred between the two systems with the power flux over an infinite sphere which arises from their interaction. The gravitational linear momentum flux which arises from the interaction is also shown to be purely quadrupole. Bonnor and Rotenberg, Papapetrou, and Peres demonstrated the quadrupole-octupole dependence for linear momentum flux from a single system, and the present work illustrates that a lower-order flux can be achieved by a double system. (auth)

13180 SYSTEMS OF SELF-GRAVITATING PARTICLES IN GENERAL RELATIVITY AND THE CONCEPT OF AN EQUATION OF STATE. Ruffini, Remo (Princeton Univ., N. J. Inst. for Advanced Study, Princeton, N. J.); Bonazzola, Silvano. Phys. Rev.; 187: 1767-83(25 Nov 1969).

A method of self-consistent fields is used to study the equilibrium configurations of a system of self-gravitating scalar bosons or spin-$\frac{1}{2}$ fermions in the ground state without using the traditional perfect-fluid approximation or equation of state. The many-particle system is described by a second-quantized free field, which in the boson case satisfies the Klein–Gordon equation in general relativity, $\nabla_\alpha\nabla^\alpha\phi = \mu^2\phi$, and in the fermion case the Dirac equation in general relativity $\gamma^\alpha\nabla_\alpha\psi = \mu\psi$ (where $\mu = mc/\hbar$). The coefficients of the metric $g_{\alpha\beta}$ are determined by the Einstein equations with a source term given by the mean value $\langle\phi|T_{\mu\nu}|\phi\rangle$ of the energy-momentum tensor operator constructed from the scalar or the spinor field. The state vector $\langle\phi|$ corresponds to the ground state of the system of many particles. In both cases, for completeness a nonrelativistic Newtonian approximation is developed, and the corrections due to special and general relativity explicitly are pointed out. For N bosons, both in the region of validity of the Newtonian treatment (density from 10^{-80} to 10^{54} g cm^{-3}, and number of particles from 10 to 10^{40}) as well as in the relativistic region (density $\sim 10^{54}$ g cm^{-3}, number of particles $\sim 10^{40}$), results are obtained which are completely different from those of a traditional fluid analysis. The energy-momentum tensor is anisotropic. A critical mass is found for a system of N $\sim$[(Planck mass)/m]^2 $\sim 10^{40}$ (for m $\sim 10^{-25}$ g) self-gravitating bosons in the ground state, above which mass gravitational collapse occurs. For N fermions, the binding energy of typical particles is $G^2m^5N^8\hbar^{-2}$ and reaches a value $\sim mc^2$ for $N \sim N_{crit} \sim$[(Planck mass)/m]$^3 \sim 10^{57}$ (for m $\sim 10^{-24}$ g, implying mass $\sim 10^{33}$ g, radius $\sim 10^6$ cm, density $\sim 10^{15}$ g/cm^3). For densities of this order of magnitude and greater, we have given the full self-consistent relativistic treatment. It shows that the concept of an equation of state makes sense only up to 10^{42} g/cm^3, and it confirms the Oppenheimer–Volkoff treatment in extremely good approximation. There exists a gravitational spin-orbit coupling, but its magnitude is generally negligible. The problem of an elementary scalar particle held together only by its gravitational field is meaningless in this context. (auth)

13181 GENERALLY COVARIANT INTEGRAL FORMULATION OF EINSTEIN'S FIELD EQUATIONS. Sciama, D. W. (Cambridge Univ., Eng.); Waylen, P. C.; Gilman, Robert C. Phys. Rev.; 187: 1762-6(25 Nov 1969).

As a basis for a generally covariant theory of Mach's principle, Einstein's field equations are expressed in integral form. The nonlinearity of these equations is reflected in the kernel of the

integral representation, which is a functional of the metric tensor. The functional dependence is so constructed that, subject to supplementary conditions, the kernel may be regarded as remaining unchanged to the first order when a small change in the source produces a corresponding change in the potential. To obtain this kernel, a linear differential operator is derived by varying a particular form of Einstein's field equations. The elementary solution corresponding to this linear operator provides the kernel of an approximate integral representation which becomes exact in the limit of vanishing variations. This representation is in a certain sense unique. Our discussion is confined to a normal neighborhood of the field point. (auth)

Scattering Theory

Refer also to abstracts 13037, 13055, 13108, and 13148.

13182 (FVE-STF-69-20) SCATTERING AS A STOCHASTIC PROCESS AT HIGH ENERGIES. PART I. Logunov, A. A.; Khrustalev, O. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). Sep 1969. 25p. (In Russian). Dep. CFSTI (U. S. Sales Only).

It is shown, that describing the stochastic part of the amplitude with a value-number of particles in an intermediate state necessary (the value, that was not considered earlier) for the transversal momentum transfer, it is possible to describe qualitatively the main properties of the elastic scattering at high energies. (auth)

13183 (FVE-STF-69-21) SCATTERING AS A STOCHASTIC PROCESS AT HIGH ENERGIES. PART II. Logunov, A. A.; Khrustalev, O. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1969. 22p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The scattering amplitude is studied with the help of previously defined stochastic variable—number of the particles transferring the given transverse momentum. (auth)

13184 QUANTIZATION CONDITIONS FOR LINEAR AND NONLINEAR TRAJECTORIES. Coon, Darryl D. (Univ. of Washington, Seattle). Contract AT(45-1)-1388. Phys. Rev.: 186: 1422-3(25 Oct 1969).

It is shown that the relation between linear trajectories of opposite normality found by Ademollo, Veneziano, and Weinberg also holds for nonlinear trajectories which occur in a generalization of the Veneziano form. It is also shown that half-integer spacing of trajectories of opposite normality which are connected by pion emission is possible only if the lowest spin particle on the upper trajectory is missing. Experimentally, there is a distinct absence of such particles (e.g., low-lying $\frac{1}{2}^-$ baryons and baryon resonances). (auth)

13185 CONSTRUCTION OF CROSSING-SYMMETRIC AMPLITUDES SATISFYING DUALITY. Bitar, Khalil M. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev.: 186: 1424-34(25 Oct 1969).

The general problem of constructing crossing-symmetric amplitudes satisfying duality for spinless two-body scattering processes is studied. An integral representation is first given for a sum of direct-channel resonance contributions. When one demands that this sum be dual and crossing-symmetric, the integrand is found to satisfy equations and asymptotic conditions, the general solutions to which are obtained. An infinity of solutions is found, implying that an infinity of amplitudes may then be constructed. The Veneziano amplitude is shown to be among the simplest. The Regge-pole content of these amplitudes is then given, and factorization is shown to be satisfied only at the expense of a degeneracy in the angular momentum spectrum. (auth)

13186 MODIFIED CONTINUOUS-MOMENT SUM RULES AND THE POMERANCHON. Chavda, L. K. (Purdue Univ., Lafayette, Ind.). Phys. Rev.: 186: 1463-9(25 Oct 1969).

A modified form of the continuous-moment sum rule is employed to investigate whether or not the Pomeranchon intercept α_P, deviates from its maximal value of unity in the forward direction. The sum rule contains a continuously varying power of the amplitude, in addition to the usual continuously-varying moment. Two particular cases, corresponding to the first and the second powers of the amplitude, are analyzed in terms of unconstrained three-pole models. The two resulting solutions agree within the errors. They have essentially the same value of α_P, viz., 0.988 ± 0.01. Both give excellent fits to high-energy data. The value quoted above is favored over unity, although it is consistent with unity. (auth)

13187 ASYMPTOTIC COVARIANT BJORKEN'S EXPANSION OF T-PRODUCTS OF ANY NUMBER OF OPERATORS. Vendramin, I. (Univ., Padua). Nuovo Cim.; 65A: 521-34(1 Feb 1970).

It is shown that an unambiguous recipe suggested by Ciccariello et al. to write the covariant asymptotic expansion of the Fourier transform of the T-products of two and three operators, is wholly generalizable to the case of any number of operators and the corresponding formula is supplied. (auth)

13188 FORM FACTORS OF IRREDUCIBLE CURRENTS AND THEIR RELATION TO THE STANDARD FORM FACTORS. Tchrakian, D. H. (Westfield Coll., London). Nuovo Cim.; 65A: 535-43(1 Feb 1970).

The matrix element of the vector (1^-) combination of the $J(1,0)$ and $\bar{J}(0,1)$ currents between nucleon states is expanded into form factors. These form factors are related to the standard Dirac and Pauli form factors occurring in the matrix element of the current $J_\mu(\frac{1}{2},\frac{1}{2})$. (auth)

13189 BRANCH CUTS IN THE BALAZS METHOD. Dilley, James (Univ. of Alberta, Edmonton). Phys. Rev.; 186: 1678-87(25 Oct 1969).

The Balázs method of parametrizing distant singularities is discussed for the case when the near part of the left-hand cut is retained explicitly. A closed-form solution of the N/D equations is derived which allows the method to be applied in a systematic manner. The solution is approximate, but can be made extremely accurate if the cut retained is not too large. The method is applied to the case of Yukawa scattering where it is shown that the addition of the cut substantially reduces the ambiguities associated with a pure-pole approach and leads to solutions in good agreement with those obtained from the Schroedinger equation. The case $l = 0$ requires separate treatment, and some modified treatments are discussed which improve the results. (auth)

13190 PHASE OF THE ELASTIC SCATTERING AMPLITUDE AND THE RATE OF DECREASE OF THE TOTAL CROSS SECTION AT HIGH BUT FINITE ENERGY. Cheung, Franklin F. K. (State Univ. of New York, Stony Brook). Phys. Rev.: 186: 1695-6 (25 Oct 1969).

It is shown that there is a definite connection between the sign of $\mathrm{Re}T(s,t)/\mathrm{Im}T(s,t)$ at high but finite energy and the fact that at high energy the total cross section is decreasing to its finite constant limit. Using plausible assumptions, $\mathrm{Re}T(s,t)/\mathrm{Im}T(s,t)$ is shown to be negative at near-forward angles. (auth)

13191 SOLUTIONS OF PARTIAL-WAVE DISPERSION RELATIONS. II. Johnson, Porter W. (Case Western Reserve Univ., Cleveland). Contract AT(11-1)-1573. Phys. Rev.; 186: 1583-92(25 Oct 1969).

The study of the partial-wave dispersion relation (PWDR) is continued, being extended to the relativistic problem in the presence of inelasticity. Less restrictive sufficient conditions on the left-hand-cut discontinuity ΔT are obtained to guarantee a solution of the PWDR problem when ΔT has both positive and negative parts. The effect of Castillejo–Dalitz–Dyson poles on solutions is also discussed. (auth)

13192 PARTIAL-WAVE DECOMPOSITIONS OF THE RELATIVISTIC SCATTERING AMPLITUDE. Tindle, Graham L. (Queen Mary Coll., London). Phys. Rev.: 186: 1484-8(25 Oct 1969).

Criteria are proposed by means of which one may determine whether or not a statement about the singularity structure of a partial-wave amplitude will be consistent with the principles of special relativity. It is suggested that none of the conventional partial-wave amplitudes satisfies these criteria. These considerations imply that there may be no simple connection between the trajecotry functions of Regge poles and the high-energy behavior of relativistic scattering amplitudes. (auth)

13193 SECONDARY TRAJECTORIES AND THE SATURATION OF FINITE-ENERGY SUM RULES. Swift, Arthur R.; Tucker, Robin W. (Univ. of Massachusetts, Amherst). Phys. Rev.; 186: 1553-9(25 Oct 1969).

A study is made of the constraints placed upon the couplings and resonance spectrum required to saturate finite-energy sum rules consistently in the region around $t = 0$. It is argued that the probable existence of crossing trajectories and cuts places a fundamental limit on the usefulness of finite-energy sum rules. The demand that the spin of the resonances increase monotonically with mass implies that an infinite number of asymptotically

parallel daughter trajectories in the resonance region are required for consistency. This result is independent of any statement about the energy dependence of the leading trajectory. (auth)

13194 PROPERTIES OF THE SCATTERING AMPLITUDE IN THE RENORMALIZED LEE MODEL AND IN A RELATIVISTIC GENERALIZATION. Collina, R. (Univ., Florence. Instituto Nazionale di Fisica Nucleare, Florence); Luzzatto, G. Nuovo Cim; 65A: 277-96(21 Jan 1970).

The scattering amplitude for the N-θ sector in the point-source Lee model is expressed in terms of only renormalized quantities. A relativistic generalization of the Lee model is then considered; equations of motion and scattering amplitudes are all expressed without reference to the unrenormalized parameters. In both cases, the analytical structure of the S-matrix shows that an extra pole comes out, as a result of infinite renormalization. (auth)

13195 INCONSISTENCY OF ASYMPTOTIC SU(2) X SU(2) FOR THE PROPER AMPLITUDES WITH LOCAL CHIRAL ALGEBRA. Acharya, R. (Univ., Bern); Aly, H. H.; Narayanaswamy, P. Phys. Rev.; 186: 1731-3(25 Oct 1969).

A recent proposal of asymptotic symmetry for the proper amplitudes is tested with reference to the Adler–Weisberger sum rule and is found to lead to an inconsistency, thereby demonstrating its incompatibility with local chiral current algebra. (auth)

13196 EXTENSION OF A CROSSING-SYMMETRIC REGGE-POLE MODEL TO AN n-POINT AMPLITUDE. Moffat, J. W. (International Center for Theoretical Physics, Trieste, Italy. Univ. of Toronto). Lett. Nuovo Cim.; 2: 773-4(1 Dec 1969).

A crossing-symmetric Regge-pole model which applies to both low- and high-energy scattering is extended to an n-point production amplitude. The case of n external identical particles with zero spin is considered. (J.F.P.)

13197 COMPACTNESS PROOFS ASSOCIATED WITH THE PARTIAL-WAVE LIPPMANN–SCHWINGER AND BETH–SALPETER KERNELS. Choudhury, M. H. (Univ. of Hull, Eng.). Nuovo Cim.; 65A: 405-10(1 Feb 1970).

The kernels of the partial-wave Lippman–Schwinger equation for potentials V(r) satisfying certain quite weak conditions and that of the partial-wave Bethe–Salpeter equation (without Wick transformation) for two equal-mass zero-spin particles in partially symmetrized forms are shown to be compact in Hilbert space. Specifically, it is shown that these kernels define linear integral operators which belong to a class of compact linear operators in Hilbert space which are wider than those of the Hilbert–Schmidt class. (auth)

13198 SOME PROPERTIES OF THE DENOMINATORS OF THE DIAGONAL PADE APPROXIMANTS. Georgalas, C. G. (Univ., Padua). Nuovo Cim.; 65A: 12-24(1 Jan 1970).

The denominator $Q_n(g)$ of the n-th diagonal Padé approximant to some power series in g, is an n-th degree polynomial in which the coefficient of g^m $(m = 1, \ldots, n)$ can be written in the form $b_m^{(n)} = -D_m^{(n)}/D_0^{(n)}$, where $D_m^{(n)}$ and $D_0^{(n)}$ are n × n determinants. Under certain assumptions, a representation of $D_m^{(n)}$ $(m = 0, 1, \ldots, n)$ in terms of n and m is obtained. This representation gives some insight into the various effects that influence the behavior of $D_m^{(n)}$ when the order n of the approximants tends to infinity. This result is then used in discussing the behavior of $Q_n(g)$ for large n. The possibility of future applications is briefly sketched. (auth)

13199 VARIABLE-PHASE APPROACH TO OFF-SHELL POTENTIAL SCATTERING. Sobel, M. I. (Brooklyn Coll.). Nuovo Cim.; 65A: 117-34(1 Jan 1970).

The variable-phase approach to potential scattering leads to a first-order differential equation for a function $\delta_l(R)$, such that $\delta_l(0) = 0$, and $\delta_l(\infty)$ is the phase shift for potential, V(r). The equation involves V(r) but does not involve the wave function. This method is applied to find first-order differential equations for the quasi-phase parameters which describe the half-off-shell matrix elements. The case of a complex potential is considered, and also the case of coupled channels. (auth)

13200 KINEMATIC SINGULARITIES OF HELICITY AMPLITUDES FOR MULTI-PARTICLE PROCESSES. Svensson, Bengt E. Y. (Univ. of California, Berkeley). Nucl. Phys.; B15: 93-117(1970).

A method used by Trueman to obtain the kinematic singularities of the cm helicity amplitudes for a 2 - to - 2 particle reaction is extended to 2 - to - n $(n \geq 3)$ multi-particle processes involving massive particles of any spin. The basic assumption is that the kinematic singularities of the multi-particle helicity amplitudes, regarded as functions of the scalar products between the four-momenta, are due to the singular behavior of the helicity states when particular Gram determinants of the four-momenta vanish. The resulting singularities are classified and explicitly isolated by giving the expansion of the helicity amplitudes near each singularity surface. (auth)

13201 MULTI-PARTICLE GENERALIZATIONS OF THE VIRASORO AMPLITUDE. Collop, D. J. (Cambridge Univ., Eng.). Nucl. Phys.; B15: 229-41(1970).

The Virasoro amplitude is generalized to production processes by a method similar to that by which the Veneziano amplitude is generalized. The amplitudes are seen to contain the Veneziano amplitudes as special cases. The pole structure is analyzed and the factorization properties considered are found not to be entirely satisfactory. (auth)

13202 MULTIPLE SCATTERING EFFECTS IN PARTICLE CREATION PROCESSES. Dean, Nathan W. (Vanderbilt Univ., Nashville). Nucl. Phys.; B15: 213-20(1970).

Rescattering effects which accompany particle creation on a composite target are calculated using a modified version of the Glauber theory. The correction terms to the creation amplitude can be evaluated for exponentially diffractive processes; they lead to a low-mass enhancement in the two-body mass spectrum. (auth)

13203 INTEGRAL REPRESENTATIONS FOR THE COMPLETE FOUR- AND FIVE-POINT VENEZIANO AMPLITUDES. Fairlie, D. B.; Jones, K. (Univ. of Durham, Eng.). Nucl. Phys.; B15: 323-30(1970).

It is shown that integral representations may be written for the four- and five-point functions which are invariant under all 24 and 120 permutations of the external lines respectively and which incorporate all the distinct terms of the Veneziano form which constitute the amplitudes, provided certain trajectory constraints are satisfied. (auth)

13204 REGGEON AMPLITUDES IN CUT DISCONTINUITIES AND MULTIPERIPHERALISM. Landshoff, P. V. (Cambridge Univ., Eng.). Nucl. Phys.; B15: 284-98(1970).

An investigation is made of the relationship that perturbation theory predicts to exist between the two-Reggeon/two-particle amplitudes appearing in (a) the discontinuity associated with the two-Reggeon cut in the elastic two-body amplitude, and (b) the residue of a two-fold Regge pole of the six-point function. Since the latter can be defined in terms of asymptotic behavior, without using perturbation theory, such a relationship would lead to an expression for the two-Reggeon cut discontinuity in terms of functions defined independently of perturbation theory. Because of the great complexity of the structure of the cut, the required relationship is found only for a "two-Reggeon-irreducible" amplitude, which is associated with the Regge cut in a manner analogous to that in which the K-matrix is associated with a normal-threshold cut. (auth)

13205 RENORMALIZATION OF REGGE TRAJECTORIES AND SINGULARITY STRUCTURE IN KIKKAWA–SAKITA–VIRASORO-TYPE THEORIES. Polkinghorne, J. C. (Univ. of California, Berkeley). Phys. Rev.; 186: 1670-7(25 Oct 1969).

An investigation is made of theories which satisfy the duality principle using the Veneziano amplitude as a Born term. In constructing the theory, it is found necessary to average over different ways of assigning the loop momenta to the points of the duality diagram. The Regge-pole terms in the asymptotic behavior are identified, and transcendental equations which express the full renormalization of the leading trajectory are recorded. (It is necessary to assume that the integrals can be so defined that this asymptotic behavior, found in the limit Res $\to -\infty$, continues to be the dominant behavior as Res $\to +\infty$.) The amplitude is shown to have the Landau–Cutkosky singularity structure corresponding to poles lying on the renormalized leading trajectory. In particular, if low-lying particles on this trajectory are the only stable particles in the theory, the real singularity structure required by unitarity is correctly obtained. It is then possible that the failure in a finite theory of exact factorization for all daughters would not spoil the theory. (auth)

13206 COMPLEX ANGULAR MOMENTUM AND REGGE ASYMPTOTIC BEHAVIOR OF THE VIRASORO MODEL. Argyres, Ernestos N. (State University Coll., Plattsburgh, N. Y.); Lam, C. S. Phys. Rev.; 186: 1532-6(25 Oct 1969).

The complex angular momentum analysis for the Virasoro model is carried out. The partial-wave amplitude A(s,l) has moving Regge poles and fixed poles at nonsense wrong-signature values of l. It has an infinite number of left-hand cuts in the s plane and a series

of poles on the positive real axis corresponding to the narrow-width resonances. An attempt is made to incorporate unitarity to A(s,l) to try to attain crossed-channel Regge asymptotic behavior for large and real t. It is shown that if only elastic unitarity is taken into account, then the attempt cannot be successful. (auth)

13207 COMMENT ON THE TOLLER-ANGLE DEPENDENCE OF MULTI-REGGE VERTICES. Steele, David; Sullivan, J. D. (Univ. of Illinois, Urbana). Phys. Rev.; 187: 2271-2(25 Nov 1969).

The implications of the fact that multi-Regge vertices are independent of the Toller angle at vanishing momentum transfer are discussed. (auth)

13208 REGGE CUT FROM A NONPLANAR DUALITY AMPLITUDE. Kikkawa, K. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Rev.; 187: 2249-52(25 Nov 1969).

The duality theory which has been proposed recently provides "essentially nonplanar" amplitudes even in those diagrams with one loop. A simple nonresonant scattering amplitude generates a moving cut and a Gribov–Pomeranchuk pole in the l plane. This also provides a simple and quite general way of calculating Regge-cut contributions. (auth)

13209 THRESHOLD EXPANSIONS, THE CHENG–SHARP EQUATION, AND THE UNITARIZATION OF REGGE PARAMETERS. Bronzan, J. B. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev.; 187: 2253-7 (25 Nov 1969).

The constraints imposed on Regge parameters by elastic unitarity are discussed. Near threshold, the constraints can be expressed in terms of the threshold expansions which are generalizations of the leading threshold behavior given by Barut and Zwanziger. With the new information contained in the expansions, the Cheng–Sharp integral equation is examined, which is an alternative means of accounting for unitarity. In the narrow-resonance limit, where it should be valid, the Cheng–Sharp scheme predicts that the threshold expansion is useful at intermediate energies, but it gives the first nontrivial term incorrectly. Finally, a simple scheme is proposed for unitarizing Regge parameters that is consistent with the threshold expansions and involves no integral equations. (auth)

13210 STUDY OF THE INFINITE-MOMENTUM LIMIT. Brandt, Richard A. (Univ. of Maryland, College Park). Phys. Rev.; 187: 2192-2210(25 Nov 1969).

A study is made of some aspects of the infinite-momentum limit $p_0 \to \infty$ of amplitudes M satisfying the requirements of Regge asymptotic behavior in the energy $s = (p-q)^2 = p^2 + q^2 - 2\nu$ (for the absorptive part) and Bjorken asymptotic behavior in the mass q^2 (we do not make essential use of space-space or time-derivative commutators). It is also studied how to incorporate the restrictions due to partial current conservation. These requirements shed much light on the nature of the $p_0 \to \infty$ limit and on the validity of its consequences. Thus, the structure of current-algebraic sum rules, including possible infinite-mass contributions, is discussed in a purely analytical way and a sharper derivation of the Fubini–Dashen–Gell-Mann sum rule is produced. To obtain a more complete understanding of the limit, simple forms are assumed for the asymptotic behavior of M in any direction in the s-q^2 plane. These model functions, which may be useful in phenomenological descriptions of asymptotic regions, smoothly interpolate between the Regge and Bjorken limits. They constitute an economical summary of the assumptions of current algebra, partial current conservation, Regge asymptotics, and validity of the infinite-momentum procedure. Although their forms are only partially justified, they lead to testable predictions concerning the saturation properties of asymptotic sum rules, the existence of new fixed-mass sum rules, and behavior in the limit $\nu \to \infty$, $q^2 \to -\infty$, ν/q^2 fixed. In terms of this model, exact criteria for the validity of interchanging the infinite-momentum limit with energy integrations can be obtained, and previous results, deduced from properties of free-field theories, can be extended to the interaction case. (auth)

13211 DIRECT-CHANNEL RESONANCES, ASYMPTOTIC BEHAVIOR OF THE SCATTERING AMPLITUDE, AND DEGENERACY OF THE RESONANCE LEVELS. Krzywicki, A. (Ecole Polytechnique, Paris. Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Phys. Rev.; 187: 1964-6(25 Nov 1969).

It is shown under rather general conditions, that duality implies the following alternatives: Either the number of mass-degenerate resonances increases very rapidly (exponentially, if resonances disintegrate according to the statistical model) with the resonance mass, or there exist very strong selection rules that effectively forbid most of the disintegration channels for a class of heavy resonances. (auth)

Particle Accelerators

Refer also to abstracts 11870, 12873, and 12876.

13212 (AWRE-O-50/69) THE DEVELOPMENT OF ACCELERATOR NEUTRON SOURCES FOR FAST REACTOR PHYSICS EXPERIMENTS. Gray, J.; Mullender, M. L.; Smith, D. L. E. (Atomic Weapons Research Establishment, Aldermaston (England)). Nov 1969. 56p. Dep. CFSTI (U. S. Sales Only). UK 10s.

Two low-energy high-current deuteron accelerators which were built at AWRE as neutron sources for fast reactor physics experiments are described. They provide the continuous sources required to maintain the neutron population in sub-critical steady-state experiments and the pulsed sources required for measuring time-dependent properties and for time-of-flight spectrometry. One of the accelerators operates at 400 kV and is associated with the low power experimental fast reactor, VERA. The other is a 300 kV accelerator which is an AWRE development of a commercial system supplied by the High Voltage Engineering Corporation and is used as a source for a sub-critical fast reactor assembly called PANDA. The accelerators and the development work which has been done on their pulsing systems and on the various operational problems which arise in their use in the fast reactor physics program are described. (W.H.K.)

13213 (BNL-50180) STUDY FOR THE EXPANSION OF THE ON-LINE DATA PROCESSING FACILITY. Dimmler, D. Gerd (Brookhaven National Lab., Upton, N. Y.). 30 Jun 1968. 17p. Dep. CFSTI.

The results of a study of the expansion of the Brookhaven On-Line Data Processing Facility (OLDF) are presented. The OLDF system monitors several direct digitizing counter experiments at the Alternating Gradient Synchrotron. An analysis is given of the past performance of the system, based on three major experiments. Several system concepts are considered for the expansion. A satellite computer system is proposed in which several satellite computers, each dedicated to one experiment, are connected to one large, central, time-shared system. (auth)

13214 (BNL-tr-295) USE OF A POLARIZED PROTON TARGET AS A NEUTRON POLARIZER. Lushchikov, V. I.; Taran, Yu. V.; Shapiro, F. L. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from report JINR-P3-4409. 47p. Dep. CFSTI.

This article was previously abstracted from the original language and appeared in NSA as 23: 42790. (C.E.S.)

13215 (CERN-Trans-69-20) ANALYTIC REPRESENTATION OF THE MAGNETIC FIELD OF A SECTOR CYCLOTRON. Kanunnikov, V. N. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translated by N. Mouravieff (CERN, Geneva, Switzerland), from Preprint No. 21. 11p. (In French). Dep. CFSTI (U. S. Sales Only).

In the approximation of the problem to two dimensions and an infinitely large magnetic permeability, one obtains analytic expressions for the field of a radial magnet in sectors composed of separate blocks. The results are in good agreement with experimental results. (tr-auth)

13216 (CERN-Trans-69-23) OBSERVATION SYSTEM OF THE 70-GeV PROTON SYNCHROTRON. Bol'shakov, Yu. D.; Gertsev, K. F.; Ivanov, Yu. S.; Kuz'min, A. A.; Rubchinskii, S. M.; Uvarov, V. A. (Akademiya Nauk SSSR, Moscow. Radiotekhnicheskii Institut). Translated by A. Golovanoff (CERN, Geneva, Switzerland), from report NTD-6827. 12p. (In French). Dep. CFSTI (U. S. Sales Only).

The beam orbit of the IHEP synchrotron is determined by measuring the displacement of the center of gravity of accelerated particle bunches within 85 azimuth points. A special system is described which allows a determination of the position of the closed orbit, as well as the frequency, amplitude, and phase of the coherent betatron oscillations. The equipment assures a precision measurement of the orbit deplacement of $\pm$ (5 to 7)% $\pm$ 1 mm for an intensity of 10^{11} to 10^{14} protons and 10 to 15% for an intensity of 10^{10} protons. (J.F.P.)

13217 (COO-1779-20) DATA ACQUISITION FROM SIMULTANEOUS EXPERIMENTS USING THE MSU SIGMA-7 COMPUTER. McHarris, Wm. C.; Au, R. F.; Bayer, D. L.; Benenson, W.; DeForest, R. A.; Kelly, W. H.; Merritt, W. E. (Michigan State Univ., East Lansing). [1968]. 16p. (CONF-690818-12). Dep. CFSTI.

From International Conference on Radioactivity in Nuclear Spectroscopy, Nashville, Tenn.

The real-time, time-sharing Sigma-7 computer system for

simultaneous data acquisition and processing at the Michigan State University cyclotron laboratory is described. It has standard peripherals plus a large general-purpose display which connects it to two scope displays, four ADC units, coincidence and routing circuitry, and a Nuclear Data 160 analyzer that can dump its memory directly into the computer. (W.H.K.)

13218 (FR-68-1/1) ELECTRON TO POSITRON CONVERSION YIELD IN THICK TARGETS. Ferdinande, H.; Jacobs, R.; Van de Vijver, R. (Ghent Rijksuniversiteit (Belgium). Natuurkundig Laboratorium). 20 Apr 1968. 19p. (CONF-680461-8). Dep. CFSTI (U. S. Sales Only).

From Professional Commission on Nuclear Physics, Bad Neuenahr, Germany.

Numerical calculations of the electron to positron conversion yield, double differential with respect to the positron energy and solid angle, were performed. The method is applicable to the positrons leaving the target in the forward direction and to thicknesses of targets wherein the buildup of secondary electrons can be neglected. The energy loss and its combination with the multiple scattering of both electrons and positrons and also the diffusion and the in-flight annihilation of the positrons were taken into account explicitly. The calculations show a fair agreement with experimental results which indicates their importance in the design of an optimum positron converter. (auth)

13219 (INR-971) THE BEAM SWITCHING MAGNET SYSTEM FOR THE VAN DE GRAAFF ACCELERATOR "LECH." Bienkowski, A.; Gorski, E.; Jaskola, M.; Rekawek, H.; Zemlo, L. (Institute of Nuclear Research, Warsaw (Poland)). 1968. 31p. (In Polish). Dep. CFSTI (U. S. Sales Only).

The construction and mounting of the beam switching magnet with power supply and the beam position stabilizer are described. (auth)

13220 (ITEF-702) CONCERNING ONE TYPE OF THE MAGNETIC FOCUSING SYSTEMS WITH COMPENSATED DISPERSION. CONCERNING ACHROMATIZATION OF BEAMS OF PARTICLES IN CASES WHEN THE MAGNETIC ANALYSIS PRECEDES THE LIMITATION OF THE BEAM. Miller, V. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1969. 32p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Magnetic systems with the compensating magnet transferred to the end of the channel are analyzed. The linear dispersion is compensated at the position of the final image and at the center of that lens of the exit doublet in which the beam has maximum horizontal spread. For these "almost achromatic" systems, a good transmission for wide bend = $\delta = \Delta p/p$ can be achieved. With focusing orders DFFFD and FDFDF. The deflection angles in the compensating magnet differ by a factor of 3 to 4. This feature permits in some cases two zero dispersion beams at the end of the system, and beam switching from one experimental site to another. Alternatively, one can have beams with compensated or enlarged dispersion without loss of the intensity. Also, it is shown, that if the analyzing magnet is placed before the aperture slit, the usual achromaticity condition ($D_x = 0$, $D'_x = 0$) results in spreading of the beam in the exit doublet. The current in the field lens must be adjusted to make (for every value $p \neq p_0$) the trajectory, crossing the center of the aperture slit, coincide with the axis of the system at its exit. In this case in linear approximation the cross section of the beams with all values of p will coincide in the exit doublet. (auth)

13221 (N-70-12207) RADIOFREQUENCY SYSTEM ANALYSIS OF THE LEWIS CYCLOTRON MODIFICATION. Fessler, Theodore E. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Dec 1969. 30p. (NASA-TN-D-5546). CFSTI.

The resonant cavity of the modified Lewis Research Center cyclotron is analyzed. The results include the variation of resonant frequency with tuning pannel position, an estimate of the skin resistance losses, the distribution of voltage along the length of the dee electrode, and a lumped-impedance equivalent circuit. Dee-to-dee coupling is analyzed for its influence on servotuning of the dees. A tuning function is presented which should make stable servotuning possible for any amount of dee-to-dee coupling. The performance of a shortened coupling line between the power amplifier and the dee stem is also analyzed. (auth) (USGRDR)

13222 (ORNL-TM-2833) PULSE-SHAPE MEASUREMENTS FOR THE OAK RIDGE ELECTRON LINEAR ACCELERATOR WITH GAMMA-RAY DETECTION TECHNIQUES. Weston, L. W.; Todd, J. H. (Oak Ridge National Lab., Tenn.). 20 Jan 1970. 13p. Dep. CFSTI.

A study of the pulse-shape characteristics of the Oak Ridge Electron Linear Accelerator was carried out because the resolution of neutron cross section and neutron spectra measurements are directly dependent upon this pulse shape. Gamma-ray detection with techniques commonly used in neutron time-of-flight experiments was used in the study because of the fidelity with which the pulse shape could be measured. (auth)

13223 (SC-RR-69-421) SUMMARY OF THE HERMES FLASH X-RAY PROGRAM. Martin, T. H.; Prestwich, K. R.; Johnson, D. L. (Sandia Labs., Albuquerque, N. Mex.). Oct 1969. 41p. Dep. CFSTI.

The Hermes program produced significant information in the areas of Marx generator design, flash x-ray tube development, dielectric breakdown, and general flash x-ray machine design. As an outcome of the Hermes program, Hermes II was constructed and is the largest flash x-ray machine presently operating. The results of investigations in the areas mentioned are summarized, and the operation of megavolt flash x-ray machines is discussed. (auth)

13224 (TID-25321) THE BEVATRON. (California Univ., Berkeley. Lawrence Radiation Lab.). Nov 1969. 17p. Dep. CFSTI.

The design and operation of the Bevatron are described as well as the experimental equipment and research carried on at the accelerator. A brief history of the Bevatron is presented, and fundamental operating parameters are listed. (W.H.K.)

13225 THE EUROPEAN LARGE ACCELERATOR BEFORE THE DECISION. THE STATE OF THE 300-GeV PROJECT AT CERN. Haunschild, H. H. Atomwirt., Atomtech.; 14: 451-2 (Sep-Oct 1969).

At the next CERN council, beginning on October 1, 1969, the decision on the position of the planned 300-GeV proton synchrotron will be made. Five of the six participating countries have proposed a site. Drensteinfurt, Goepfritz, and Le Luc in France are in primary positions because of geotechnical and topological criteria. Drensteinfurt and Doberdo best fulfill the criteria of operation and habitability. Only Drensteinfurt fulfills both aspects. Also in a political decision the low number of international devices in the BRD should offer a strong argument for Drensteinfurt. (tr-auth)

13226 PUMPING SYSTEM OF THE IPCR 160 cm CYCLOTRON. Tonuma, Tadao, Miyazawa, Yoshitoshi (Inst. of Physical and Chemical Research, Yamato, Japan). Shinku; 12: 405-16(Nov 1969). (In Japanese).

The IPCR 160 cm cyclotron has a vacuum chamber, i.e., the accelerating chamber, of which the volume is 1×10^4 l and the surface areas in vacuum is about $140m^2$. Many parts, such as dees, ion source and surface shim coils and other undesirable outgassing sources are included in the accelerating chamber. Therefore, vacuum pumps are required to obtain high vacuum in the presence of much outgassing and to have small pump-down time from atmosphere. The pumping system is composed of 32'', 14'' and 6'' oil diffusion pumps in series to promote self purification of the oil. Data with regard to the 32'' oil diffusion pump, including pumping speed for varying jet gaps and heater wattage, are given. In normal operation the pumping speeds of the 32'' oil diffusion pump are 2×10^4 l/sec and at the connection between the pumping system and the accelerating chamber are about 1×10^4 l/sec with the baffle. The rough pumping system consists of a 1500 l/min rotary pump and a $300M^3/h$ roots pump with a 650 l/min rotary backing pump. When there is much outgassing, the roots pump is connected with the 14'' oil diffusion pump in order to evacuate with large throughput. Outgassing throughput during pumping down was measured under several conditions. In the early stage, the base pressure in the accelerating chamber was 1×10^{-5} Torr and operating pressure $1 \sim 2 \times 10^{-5}$ Torr. But its base pressure has been improved to $1 \sim 2 \times 10^{-6}$ Torr and operating pressure to $2 \sim 5 \times 10^{-6}$ Torr after replacing rubber water pipes with metallic flexible ones. The amount of leakage of the accelerating chamber is less than 0.3 lus and total throughput about 2 lus including outgassing. (auth) (NSA of Japan)

13227 PARTICLE ACCELERATING DEVICE. Katagiri, Shingiro (to Hitachi Ltd.). Japanese Patent 1969-24200. 14 Oct 1969. Filed 22 Dec 1965.

In the particle accelerating device proposed, the insulation breakdown occurring in the cable connecting an accelerator and a high-voltage generator can be prevented effectively. The breakdown is caused by the discharge in the accelerator. The proposed method has further advantages of the reduction in damage of accelerating-electrode surfaces, and the suppression of abnormal voltage in the voltage generator. The particle accelerating device as a whole consists of a high-voltage generator, a highly evacuated accelerator, and an insulated, high-tension cable connecting the

two. To prevent the insulation breakdown in the cable due to discharge in the accelerator, a three-electrode discharge gap device is installed in the d.c. high-voltage generator. The primary discharge in an auxiliary gap occurs responding to the transient voltage in the high voltage generator due to the vacuum discharge in the accelerator, and subsequently secondary discharge takes place in a main gap, thus the high-voltage generator is earthed. (NSA of Japan)

13228 CHARGED-PARTICLE SOURCE DEVICE. Matsui, Isao (to Hitachi Ltd.). Japanese Patent 1969-24198. 14 Oct 1969. Filed 25 Oct 1965.

A high-voltage charged-particle source for a three-electrode electron gun of a linear accelerator is described. The advantages obtained are the reduction of the cost of power source, due to the absence of a bias power source to remove dark current, and the easy operation due to avoidance of setting the bias voltage. In the power source for generation of charged particles, a pulse transformer is used, in which a coaxial cable is wound for at least two windings in plural secondary windings. The number of turns for the coaxial cable is larger than that for the winding to supply voltage to the charged-particle source. The winding of the coaxial cable is used for transmitting the signal voltage to the charged-particle current control. (NSA of Japan)

13229 METHOD FOR PRODUCING A MAGNETIC POLE OF THE BETATRON. Suematsu, Shigeru; Masuda, Masami. Japanese Patent 1969-24199. 14 Oct 1969. Filed 9 Sep 1964.

By the method proposed, a magnetic pole of high mechanical strength for use in a betatron can be produced. The pole is an assembly of multi-plate sector blocks, and each block is produced as follows. The block itself is a pile of several segments consisting of multi-layered silicon-steel plates. The segments are piled in order of length, and the end of each segment is aligned to form the circumference of a sector. In constructing the whole sectorial block, the shortest segment and the first plate of the next segment are spot-welded together, then this spot-welded segment, the remaining part of the next segment, and the first plate of the third segment are put together and spot-welded. This operation is repeated down to the longest segment. A sheet of insulating paper is inserted between the first and the second plates of silicon steel in each segment. (NSA of Japan)

13230 EFFECT OF MAGNETIC CORE CONSTRUCTION ON ELECTRON ORBITS IN THE BETATRON. Hattori, Hiroyuki (Shimadzu Seisakusho Ltd., Kyoto). Denki Tsushin Gakkai Zasshi; 89-8: 1578-84(Aug 1969). (In Japanese).

In the Shimadzu 24 MeV Betatron (test machine), the production of X-rays was observed even when the magnetic flux density was far below the saturation flux density at the pole center. This phenomenon was studied, and an explanation is reported. The sudden change of electron orbit was attributed to the saturation at the lap-joint of the yoke sheets. The gap in the lap-joint varied from 0.1 mm to 0.5 mm and caused the asymmetric disturbance of flux. Calculations were made to ascertain this effect. Construction of a yoke by butt-joint may avoid this trouble, but the vibration and noise are more trouble, especially for a medical radiation apparatus. Lamination of frame-shaped sheets is most suitable to avoid both difficulties. Moreover, the reduction of vibration extends the life time of the accelerator tube. The mechanical strength of the magnet is increased so that the whole apparatus can be made more compact. (NSA of Japan)

13231 CHARGED-PARTICLE ACCELERATION BY INTENSE ELECTRON STREAMS. Rander, J. (Physics International Co., San Leandro, Calif.); Ecker, B.; Yonas, G.; Drickey, D. J. Phys. Rev. Lett.; 24: 283-6(9 Feb 1970).

Accelerated protons and ions are observed when an intense relativistic electron stream is propagated through a gas-filled region. Several proton momentum peaks are observed for each stream pulse with a spread of ≤10%, consistent with the resolution. Proton energies are independent of the filling gas for H_2, N_2, and air. Total ion fluxes are 10^{13} to 10^{15} particles/stream pulse. Nitrogen-ion tracks were too short to determine the charge state and hence the energy, but estimated upper limits suggest +4 or +5, consistent with the energy-to-change ratio observed for protons. (auth)

13232 ENHANCEMENT OF MAXIMUM GRADIENTS IN THE COILS OF PULSE TRANSFORMERS IN ACCELERATOR PRE-INJECTORS. Babalin, A. I.; Zablotskaya, G. R.; Roife, I. M.; Yakovlev, S. P. Prib. Tekh. Eksp.; No. 4, 94-8(Jul-Aug 1969). (In Russian).

The results of investigations of maximum electric field gradients in the insulation of coils of pulse transformers used for the high-voltage supply of preinjection acceleration tubes for high-energy accelerators are given. It is shown that an increase in load capacitance leads to the increase of maximum gradients. (tr-auth)

13233 THE 100-keV ION ACCELERATOR ILU WITH MASS SEPARATION OF IONS. Gusev, V. M.; Busharov, N. P.; Naftulin, S. M.; Pronichev, A. M. (Inst. of Atomic Energy, Moscow). Prib. Tekh. Eksp.; No. 4, 19-25(Jul-Aug 1969). (In Russian).

The small ion accelerator ILU for accelerating monovalent ions up to 100 keV with mass separation of ions is described. The use of divalent and trivalent ions permits particle energies up to 300 keV. Experimental results on semiconductor drifting using the ILU accelerator are given. (tr-auth)

13234 PLASMA SOURCE OF ELECTRONS. Gridneva, G. N.; Perevodchikov, V. I.; Timofeeva, G. G.; Yumatov, K. A. (All-Union Electrical Engineering Inst., Moscow). Prib. Tekh. Eksp.; No. 4, 27-30(Jul-Aug 1969). (In Russian).

The construction and characteristics of a plasma source of electrons producing focused electron beams up to 1.5 amp and 30 keV are examined. (tr-auth)

13235 ORIENTATION OF TARGETS BY BEAM EXCITATION. Bersohn, R. (Columbia Univ., New York); Lin, S. H. Advan. Chem. Phys.; 16: 67-100(1969).

Reference is made to the large class of phenomena in which a beam of particles is directed on to a target comprised of particles oriented isotropically; as a result the excited target particles are anisotropically distributed, and the net result is that the beam gains entropy at the expense of the excited target particles, which become "pumped" to some degree. The orientation caused by the collision is manifested in an anisotropy of direction of emission and sometimes an orientation of the intrinsic angular momentum of the emitted particle. This anisotropy and polarization can be diminished either by relaxation processes within the target medium or by imparing a magnetic field or a resonant radio-frequency. Topics discussed include: Optical pumping-photon beam on atomic target with photons emitted (distribution in the excited state; polarization of emission of the optically pumped atoms); photon beams and molecular targets (angular distribution of excited molecules; depletion of the ground state; photoconverted product; classical treatment of polarization of emitted photons; angular distribution of emitted molecular fragments); anisotropic excitation of atoms and molecules by electron impact (the high energy limit; excitation of molecules by medium energy electrons); polarized neutron beams; orientation of intermediates (electric dipole transition from an orientated state J, M, to a state J_2M_2; dipole-dipole energy transfer from aligned donors to random acceptors; photosensitized dissociation of molecules). 25 references. (UK)

13236 NOTRE DAME LAMB-SHIFT POLARISED ION SOURCE. Michel, G.; Corrigan, K.; Meiner, H.; Prior, R. M.; Darden, S. E. (Univ. of Notre Dame, Ind.). Nucl. Instrum. Methods; 78: 261-73(1970).

The Lamb-shift polarized ion source in use with the Notre Dame tandem Van de Graaff accelerator is described and some of the stages in its development are reviewed. Results of initial measurements of the polarization are given. (auth)

13237 QUADRUPOLE ENERGY FILTER. Schmidt, Conrad (York Univ., Toronto). Rev. Sci. Instrum.; 41: 117-21(Jan 1970).

The electrostatic quadrupole field can be applied as an energy filter using the telescopic trajectories in a plane normal to the hyperbolic electrodes. Particle dynamics, focusing properties, and energy dispersion are given for instruments with cylindrical or rotational symmetry. The cylindrically symmetric field has unidirectional focusing of the second order, while the rotationally symmetric field has bidirectional focusing of the second order. (auth)

13238 INVESTIGATIONS ON THE EFFECTIVE LENGTH OF ASYMMETRIZED QUADRUPOLE LENSES. Kiss, A. (Inst. of Nuclear Research, Debrecen, Hungary); Koltay, E.; Ovsyannikova, L. P.; Yavor, S. Ya. Nucl. Instrum. Methods; 78: 238-44(1970).

It is shown, that different effective lengths belong to the focusing and deflecting fields superimposed in asymmetrized quadrupole lenses. The difference is calculated and/or measured for various electrode configurations. The concave cylindrical electrode lens emerges from among the investigated ones for exhibiting the smallest difference between symmetrical and asymmetrical effective lengths. The difference can be taken into account with a simple modification of the transfer matrix given for the rectangular model. (auth)

13239 ISOCHRONOUS CYCLOTRON AND HIGH-RESOLUTION NUCLEAR SPECTROSCOPY. Parkinson, W. C.; Bardwick, J.

(Univ. of Michigan, Ann Arbor). Nucl. Instrum. Methods; 78: 245-54(1970).

The practical limitations on high-resolution charged-particle spectroscopy imposed by the size and brightness of the effective source from an accelerator are discussed. Methods of measuring the characteristics of the source, and the parameters of the ion-optical system are described. Results of such measurements with an isochronous cyclotron as the source, are given. The technique for calibration of the spectrometer is described. (auth)

13240 SPECIMEN HOLDER FOR LOW TEMPERATURE ELECTRON IRRADIATION OF METALLIC RESISTIVITY SPECIMENS. Dworschak, F.; Neuhaeuser, J.; Schuster, H.; Wollenberger, H.; Wurm, J. (Kernforschungsanlage, Juelich, Ger. Technische Hochschule, Aachen). Rev. Sci. Instrum.; 41: 64-7 (Jan 1970).

A mounting of metallic resistivity specimens is described which allows low temperature electron irradiation within the vacuum system of the particle accelerator. The heat generated in the specimens during irradiation is transferred to the specimen holder via solderable sapphire plates which provide a good thermal contact and also the electrical insulation required. The temperature distribution in the specimens is calculated for general parameters. The maximum specimen temperature can be monitored continuously during the irradiation. Good agreement is found between calculated and measured maximum temperature. (auth)

13241 THE DUTY-CYCLE MONITOR: APPARATUS FOR CONTINUOUSLY MEASURING THE COEFFICIENTS UTILIZING THE OUTLET BUNCH FROM THE SYNCHROCYCLOTRON. Levy, Ph. (Univ. Clermont-Ferrand, Montlucon, France). Nucl. Instrum. Methods; 78: 219-22(1970). (In French).

An apparatus designed to monitor continuously the duty-cycle produced by the synchrocyclotron at CERN is described. The accidental coincidence-rate is measured by the delayed coincidence-method and the duty-cycle is calculated by an analog computer; automatic commutation gives the possibility to work with an acceptable range of input-rates, permitting continuous adjustment of the machine and the experimental optimization of the compromise between intensity and duty-cycle for a given experiment. (auth)

13242 DIPOLE, QUADRUPOLE, AND HIGHER ORDER FIELDS FROM SIMPLE COILS. Coupland, J. H. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Instrum. Methods; 78: 181-4(1970).

A harmonic analysis method of calculation is presented where the importance of the field coefficients so obtained may be readily assessed in relation to the proposed use for the magnet. As an example, the field from four simple sectored coils of alternate sense but arranged one per pole is calculated. It is then shown that if each coil has one, two or more suitably chosen azimuthal spacers a progressively purer quadrupole field can be obtained in the central bore. The analysis applies "pro rata" to dipole, sextupole or any other higher order system. In conclusion a simple "combined-function" magnet for beam bending and focusing is suggested. (auth)

13243 A POLARIZATION ANALYSER FOR 40- TO 50-MeV PROTONS. Tschalaer, C.; Batty, C. J.; Kilvington, A. I. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Instrum. Methods; 78: 141-50(1970).

A spin polarization analyzer of high efficiency has been designed and built for protons between 40 and 50 MeV. It is based on a measurement of the left-right asymmetry in the scattering from a set of carbon targets. Its novel feature is an energy degrader used for defining the effective scattering geometry and for suppressing inelastic events. A scattering yield of 9×10^{-4} and an analyzing power of 0.49 was achieved. The corresponding figure of merit of 2.1×10^{-4} is four times better than that of the best previously known analyzer. (auth)

13244 A SIMPLE METHOD FOR DETERMINATION OF THE OPTIMUM PHASE ANGLE OF AN ION BUNCH IN THE KLYSTRON BUNCHER FOR AN ACCELERATOR PULSER. Truetzschler, K.; Wiesner, K. (Technische Hochschule, Dresden). Nucl. Instrum. Methods; 78: 125-30(1970). (In German).

A simple method is described for determination of the correct phase angle of an ion burst into a klystron buncher of a ns-beam-pulsing system. The time calibration of the time-to-amplitude converter was performed with a new method which makes use of the klystron-beam-bunching and of a stop-signal from the rf-voltage driving the chopper. (auth)

13245 ON-LINE ISOTOPE SEPARATION AT THE HILAC. Nitschke, J. M. (Univ. of California, Berkeley). Nucl. Instrum. Methods; 78: 45-69(1970).

An on-line isotope separator was developed at the HILAC. The heavy ion beams impinges on a thin target, and the recoiling product nuclei are stopped in a solid or liquid catcher. They diffuse out of this catcher at high temperatures and are ionized by a rotating electron cloud. The ions are focused with a rf quadrupole lens into a Paul mass filter. Thereafter they are subjected to analysis by conventional nuclear radiation spectroscopy. The principle of the instrument and the results of the first on-line runs are reported. (auth)

13246 A BEAM MONITOR SYSTEM FOR HIGH-INTENSITY PHOTON BEAMS IN THE MULTI-GeV RANGE. Fischer, G. E.; Murata, Y. (Stanford Univ., Calif.). Nucl. Instrum. Methods; 78: 25-39(1970).

A system of instruments used to monitor the high-power SLAC photon beam is described. Operational experience in a series of photoproduction experiments shows an overall accuracy of ±1% with beam powers from 100 W to 3.5 kW at bremsstrahlung end point energies from 5 to 18 GeV. Monitors described include calorimeters, small secondary emission quantameters, and a Cherenkov light monitor. (auth)

13247 HYSTERESIS FREE RANGING OF VAN DE GRAAFF BEAM ENERGY. Lefevre, H. W. (Australian National Univ., Canberra). Nucl. Instrum. Methods; 78: 314-16(1970).

An air core coil is used to add or subtract an incremental deflection of the analyzed beam from a Van de Graaff accelerator. The slit current-corona tube feedback system then forces a change in terminal voltage in the normal way. (auth)

13248 MULTIPLY CHARGED HEAVY IONS FROM A STANDARD 5.5 MeV VAN DE GRAAFF. Busch, G.; Lehmann, L.; Spehl, H. (Univ., Freiburg i. B.). Nucl. Instrum. Methods; 78: 321(1970).

The standard equipment of the High Voltage Engineering Pulse Terminal of the 5.5 MeV Van de Graaff has been used for the production of multiply charged ^{12}C and ^{20}Ne ions up to 16.5 MeV. (auth)

13249 USE OF 50 psec LINAC BEAM FOR HIGH-RESOLUTION NEUTRON TIME-OF-FLIGHT MEASUREMENT. Knowlen, R. B.; O'Dell, A. A. (EG and G, Inc., Goleta, Calif.). Nucl. Instrum. Methods; 78: 300-4(1970).

The 50-psec high-intensity (14 A, 20.5 MeV) beam from the EG&G/AEC electron linear accelerator was used with subnanosecond timing techniques to make high-resolution (80 psec/m) neutron time-of-flight measurements over a short (25.35 m) flight path. The fast-neutron transmission through a carbon absorber was measured by an NE-102 organic fluor scintillation detector, and the results were used to determine the total neutron cross section for carbon over the energy range of 2.05 to 3.4 MeV. Total cross-section values obtained show good agreement with those determined by others using longer flight paths. Apparatus and techniques used in this experiment are described in detail. (auth)

13250 POLARIZED ^{55}Co TARGET USED WITH POLARIZED FAST NEUTRONS. Nagamine, K. (Tokyo Univ.). Nucl. Instrum. Methods; 78: 285-94(1970).

The design and performance of the polarized ^{55}Co target used in the experimental study of the nuclear spin-spin interaction are described. A high degree of nuclear polarization was achieved at the temperature produced by a large-scale adiabatic demagnetization, with the aid of the hyperfine splitting and the ferromagnetic state of the target sample which was three discs of polycrystalline metal of $Co_{0.99}-Fe_{0.10}$ alloy (7.5 g and $Nt = 3.61 \times 10^{22}$ atoms/cm^2). It took 6.0 hours for the system to warm up from 0.030 ± 0.003 K (P_I = 47 ± 5%) to 0.048 ± 0.005 K (P_I = 30 ± 3%). (auth)

13251 LIQUID HELIUM CRYOSTAT FOR ELECTRON IRRADIATION AND ANNEALING STUDIES. Werner, Z. G.; Whitehouse, J. E. (Univ. of Reading, Eng.). Rev. Sci. Instrum.; 41: 134-5(Jan 1970).

A cryostat for high-energy electron irradiation of semiconductors at temperatures near 4.2 K is described. (W.H.K.)

13252 POSITIONING AND FOCUSING OF THE ACCELERATOR BEAM. Picot, A. (Laboratoire de Physique des Milieux Ionises, Nancy). Nucl. Instrum. Methods; 77: 333-4(1970). (In French).

A simple electrostatic system that allows an accurate examination of the accelerator beam position and size is described. (auth)

13253 SIMPLE AIR-BEARING PULLEY. Binnie, D. M.; Duane, A. (Imperial Coll. of Science and Tech., London). Nucl. Instrum. Methods; 77: 329-30(1970).

Experience with a simple pulley for floating-wire measurements

of charged-particle trajectories in a magnetic field to less than 1 part in 10^3 is described. (auth)

13254 USE OF IMPLANTED TARGETS IN DOPPLER-SHIFT LIFETIME MEASUREMENTS. Bister, M.; Anttila, A. (Univ., Helsinki). Nucl. Instrum. Methods; 77: 315-19(1970).

The possibility of using targets, in which the ions are implanted into the backing material, in Doppler-shift attenuation measurements of lifetimes of nuclear states excited in proton capture reactions has been investigated. The effect of various uncertainties in the stopping power values on the results has also been computed. The analysis is applied to the determination of the lifetime of the 2641 keV state in ^{25}Na and the lifetime of the 4617 keV state in ^{28}Si. (auth)

13255 MULTICHANNEL INTEGRATOR AND SCANNER FOR WIRE PLANE BEAM PROFILE DISPLAYS. Hornstra, F. Jr.; Simanton, J. R. (Argonne National Lab., Ill.). Nucl. Instrum. Methods; 77: 303-5(1970).

A multichannel analog integrator followed by an electronic scanner routinely generates oscilloscope displays of external proton beam profiles from wire plane monitors at the Zero Gradient Synchrotron. The profiles are generated each machine cycle of the synchrotron or more frequently. Beam line monitoring is now possible by directly sensing the fundamental properties of the beam position and size. As a result, a simple, meaningful, quantitative monitoring tool is provided as an alternative to monitoring all beam transport elements. (auth)

13256 PRODUCTION OF A NANOSECOND-PULSED He^{++} BEAM FROM A STANDARD 5.5 MeV VAN DE GRAAFF ACCELERATOR. Thornton, S. T.; Ritter, R. C.; Hills, D. A. (Univ. of Virginia, Charlottesville). Nucl. Instrum. Methods; 77: 306-8(1970).

A standard HVEC 5.5 MV Van de Graaff accelerator and ion source have been used to produce an average beam current of 20 nA of He^{2+} ions with a pulse width less than 2.5 nsec at a repetition rate of 2 MHz. A time pickoff located on the mass 2 port of the 90° analyzing magnet was used to provide a signal from the He^{+} beam component to trigger the beam deflection system of the Mobley magnet and to stop the time to amplitude converter (TAC) used to measure the neutron time-of-flight in a nuclear scattering experiment. (auth)

13257 THIRD ORDER TRANSFER MATRICES OF THE FRINGING FIELD OF INHOMOGENEOUS MAGNET. Matsuda, H.; Wollnik, H. (Justus Liebig Univ., Giessen, Ger.). Nucl. Instrum. Methods; 77: 283-92(1970).

All ion optical fringing field effects of an inhomogeneous magnet are described in the transfer matrix representation. The resulting 49 × 49 matrices include all radial effects due to oblique and curved field boundaries in a third order approximation. The elements of the 10 × 10 axial transfer matrices necessary to describe all corresponding axial effects in a second order approximation are also derived. The necessary radial shifts of the optic axes are determined in a third order approximation. (auth)

13258 KLYSTRON BUNCHING SYSTEM FOR 6 MeV VAN DE GRAAFF ACCELERATOR. Tykesson, P.; Wiedling, T. (Aktiebolaget Atomenergi, Studsvik, Sweden). Nucl. Instrum. Methods; 77: 277-82(1970).

A klystron bunching system installed in a 6 MV Van de Graaff accelerator is described in some detail. Its properties have been thoroughly tested under various working conditions. The minimum pulse widths obtained at accelerator potentials from 1.5 to 5 MV have been investigated, as well as the peak current gain. It was found that the pulse width decreases from about 1.4 ns at 1.5 MV to 0.8 ns at 5 MV when measured at a short distance from the stabilizing slits of the accelerator. Analyzed mean currents of 7 μA are obtained at these short pulse widths and 1 MHz repetition rate. (auth)

13259 CHOPPING OF A FAST PARTICLE BEAM BY THE BEAT FREQUENCY METHOD. Chehab, R.; Brunet, P.; Buffet, X.; Melard, L.; Plages, M. (Ecole Normale Superieure, Orsay, France). Nucl. Instrum. Methods; 77: 229-34(1970). (In French).

The chopping of the electron beam in order to obtain modulation providing very short pulses is described here. The method uses a deflector whose frequency is different from that of the accelerator By "straining" the beam at the minimum of its deflection—using a collimator—one obtains nanosecond bursts whose separation is imposed by the frequency of the deflector. Adjustment of radio-frequency deflecting power and the aperture of the collimator permits variation of burst width. (auth)

13260 HIGH MOMENTUM SINGLE STAGE ELECTROSTATICALLY SEPARATED BEAM. Blum, W.; Jobes, M.; Miller, D. B.; Neale, W. W.; Rushbrooke, J. G. (CERN, Geneva). Nucl. Instrum. Methods; 77: 203-9(1970).

A beam line giving high momentum particles separated electrostatically is described. A new beam tuning technique using pencil beams, and a method of track labeling in a bubble chamber are discussed. (auth)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 11548, 13212, and 13214.

13261 PLURAL NEUTRON SCATTERING CORRECTION BY AN ANALYTICAL METHOD. Kuijper, P.; Veefkind, J. C.; Jonker, C. C. (Vrije Univ., Amsterdam). Nucl. Instrum. Methods; 77: 55-60(1970).

A plural scattering correction for neutron scattering experiments where triple scattering can be neglected with respect to the experimental errors is presented. In the analytical calculations no simplifying assumptions have to be made. The method is suitable for cylindrical scatterers with dimensions up to the mean free path of the neutrons. An alternative correction method via an adjusted neutron attenuation correction is discussed. (auth)

13262 CHARACTERISTICS OF A NEUTRON SOURCE WITH AVERAGE ENERGY 200 keV FOR BIOLOGICAL EXPERIMENTS ON THE IRT-2000. Troitskii, N. A.; Drozd, G. G.; Naumov, V. A. (Inst. of Genetics and Cytology, Minsk. Inst. of Nuclear Energetics, Minsk). Radiobiologiya; 9: 778-81(1969). (In Russian).

A method of obtaining beams of neutrons with energies in the range of tens to hundreds of keV from nuclear research reactors by filtering the reactor neutrons through thick layers of metals is outlined. The spectrometric and dosimetric characteristics of the neutron beam with average energy 200 keV, isolated with a boron-iron filter, are cited. (tr-auth)

13263 FOCUSING ACTION OF THE HIGH-VOLTAGE GAP IN A GAS-FILLED NEUTRON TUBE. Gel, E. P.; Dyad'kin, I. G. Tr., Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 1, 151-60(1968). (In Russian).

A procedure for calculating the electrical field in the high voltage gap of a gas filled neutron tube is described. The calculation, carried out on a computer, is based on the solution of the Laplace equation by a Monte Carlo method. Using this procedure, the field of the high voltage gap in a serially produced UNG-1 neutron tube is calculated. The electro-optical properties of the lens formed by the ion source, high-voltage electrode, and casing of the instrument are examined. (Geophys. Abstr.)

13264 DEFOCUSING OF AN ION BEAM ON THE TARGET OF A NEUTRON TUBE. Voytsik, L. R.; Erozolimskii, B. G. Tr., Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 1, 148-51(1968). (In Russian).

A series of measurements was made to determine the optimum position of the target in a neutron tube, based on the use of secondary electron emission with a metallic surface surrounding the target under the action of a beam of ions. The experimental results provide a basis for selecting the optimal depth of the cylindrical high voltage electrode of the tube; for the average parameters used in practice, that optimum value is 50 to 60 mm. (Geophys. Abstr.)

13265 MEASUREMENT OF NEUTRON SLOWING DOWN TIME IN LIGHT WATER, ICE, PARAFFIN, AND SANTOWAX. Sakamoto, Shigeyasu; Kaneko, Yoshihiko; Akino, Fujiyoshi (Tokyo Univ.). J. Nucl. Sci. Technol. (Tokyo); 6: 671-7(Dec 1969).

Measurements of the neutron slowing down times in light water, ice, paraffin, and santowax were made by the pulsed neutron technique. Bursts of D-T neutrons of 0.1 μsec width were generated in moderator cubes of $40 \times 40 \times 40$ cm^3. The slowing down neutrons were detected by bare as well as energy-selective filter-covered BF_3 counters, and analyzed with a 256-channel time analyzer. Slowing down times in the moderator were determined by interpreting the increment of the difference of events between the two counters as attributable to the fraction of the neutrons slowing down at the time of measurement below the cut-off energy of the filter. The measured slowing down times below 0.63 and 0.43 eV agreed well with theoretical values on the 0°K free gas model. On the other hand, the measured values below 0.20 eV were found to be appreciably greater than the theoretical, which would appear to indicate that the effect of thermal agitation and chemical binding come into play at this range of energy. (auth)

13266 IMPORTANCE: THE ADJOINT FUNCTION. THE PHYSICAL BASIS OF VARIATIONAL AND PERTURBATION THEORY IN TRANSPORT AND DIFFUSION PROBLEMS. Lewins, Jeffery. Oxford; Pergamon Press Ltd. (1965). 191p.

The basis of variational and perturbation methods for diffusion and transport problems in reactor physics is examined. The adjoint function is given a physical interpretation, the importance, in terms of a single characteristic of a system. From this concept adjoint equations are derived for the various forms of diffusion and transport theory. The principle applications of the adjoint function are discussed and appropriate examples are given. (119 references.) (J.W.R.)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 12924, 13120, and 13124.

13267 (BMwF-FBK-69-38) A CALCULATION FOR THE $3/2^+$ RESONANCE OF ^{5}He. Heiss, P. (Tuebingen Univ. (West Germany). Institut fuer Theoretische Physik). Nov 1969. 64p. (In German). Dep. CFSTI (U. S. Sales Only).

In the framework of the cluster model a method for the calculation of light nuclei scattering states is presented. Starting from simplified nucleon-nucleon forces it was possible to describe the $3/2^+$ state of ^{5}He and especially the ^{4}He-n $D3/2$ resonance. (auth)

13268 THE BINDING ENERGIES OF s-SHELL NUCLEI. Law, J.; Bhaduri, R. K. (McMaster Univ., Hamilton, Ont.). Can. J. Phys.; 47: 2825-34(15 Dec 1969).

The binding energies of ^{4}He and ^{3}H with soft- and hard-core nucleon–nucleon potentials were calculated. With central forces, using harmonic-oscillator wave functions, it was found that accurate results can be obtained by taking only the long-range part of the potential and its second-order perturbative term. When tensor forces are present, the long-range interference term is also included in the calculation. In this case, the method is not accurate and underbinds these nuclei by about 1 MeV per particle. Ignoring Coulomb forces, the method yields a value of 18.5 MeV for the binding energy of ^{4}He with the Hamada–Johnston potential. (auth) (Canada)

13269 THEORETICAL ANALYSIS OF p + ^{4}He REACTIONS AT 46.7 MeV. Sawada, Tatsuro (Univ. of Southern California, Los Angeles. Univ. of California, Los Angeles); Paic, G.; Epstein, M. B.; Rogers, J. G. Nucl. Phys.; A141: 169-92 (1970).

Using the plane-wave Born approximation (PWBA), angular distributions and energy spectra of p + ^{4}He reactions are analyzed taking into account the final-state interaction (FSI) between the final state nucleon pair in their relative S-state. Reasonable agreement with angular distributions can be obtained by introducing a lower cutoff in the radial overlap integrals. Effects of the cutoff in the energy spectra are discussed and found to be important. Results of a calculation with the distorted wave Born approximation (DWBA) of the ^{4}He(p,d)^{3}He reaction are also presented. (auth)

13270 PROTON–PROTON FINAL-STATE INTERACTION IN THE THREE-NUCLEON REACTION p + d → p + p + n. Brueckmann, H.; Kluge, W.; Matthaey, H.; Schaenzler, L.; Wick, K. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). Phys. Lett.; 30B: 460-2(24 Nov 1969).

The three-nucleon reaction p + d → p + p + n was investigated at a deuteron bombarding energy of 52.3 MeV. A kinematically complete experiment was carried out with the aim to observe the proton-proton final-state interaction. By using the Watson–Migdal model a proton-proton scattering length of $a_{pp} = -7.5 \pm 0.5$ fm is extracted from the measurements. (auth)

13271 ABSORPTION CROSS-SECTION OF DEUTERIUM. Silk, M. G.; Wade, B. O. (United Kingdom Atomic Energy Authority, Harwell, Eng.). J. Nucl. Energy; 23: 625-9(Dec 1969).

The isotopic purity of D_2O was re-examined, and slight systematic error through the omission of bucklings above 75 m^{-2} (NSA, 23: 21221) was removed. Revised values of the absorption cross section at 2200 m/sec were estimated to be 1.311 ± 0.052 mb for the D_2O molecule and 0.523 ± 0.029 mb for D_2. On combining the results with other measurements, a best estimate of 0.528 ± 0.009 mb was obtained for the D_2 cross section, and 1.321 ± 0.031 mb for the D_2O molecule. (UK)

13272 POLARIZATION OF TRITONS SCATTERED FROM HYDROGEN. Veeser, L. R.; Armstrong, D. D.; Keaton, P. W. Jr. (Los Alamos Scientific Lab., N. Mex.). Nucl. Phys.; A140: 177-89(1970).

The polarization of tritons scattered from hydrogen was mea-

sured at four triton energies between 6.4 and 9.5 MeV to determine the analyzing power of hydrogen for polarized tritons. (auth)

13273 MEASUREMENT OF POLARIZATION EFFECTS IN THE $^2H(d,p)^3H$ REACTION AT 140 keV. Steinberg, R. I.; Drake, C. W.; Bonar, D. C. (Yale Univ., New Haven). Phys. Rev.; 186: 1059-68(20 Oct 1969).

The vector analyzing power $D_2(\theta)$ and the tensor analyzing powers $D_{33}(\theta)$ and $[D_{11}(\theta) - D_{22}(\theta)]$ of the $^2H(d,p)^3H$ reaction were measured at a mean deuteron energy of 140 keV using a beam of polarized deuterons from the Yale polarized-ion source and a 100-keV-thick target of unpolarized deuterated polyethylene. The results for the vector analyzing power are in agreement with previous measurements by Ad'yasevich et al. at 100 and 200 keV and are consistent with a theoretical treatment by Rook and Goldfarb. In the notation of this treatment, the results are $B_3/B_0 = 0.321 \pm 0.059$ and $B_4/B_0 = -0.036 \pm 0.042$. The results for the tensor analyzing powers are in reasonable agreement with a previous measurement by Ad'yasevich et al. at 165 keV and are not consistent with the Rook–Goldfarb treatment in that a small contribution from quintet-state reaction matrix elements is apparent. The experimental results for the tensor analyzing powers are given by $B_5/B_0 = -0.059 \pm 0.015$, $B_5'/B_0 = -0.556 \pm 0.102$, and $B_7/B_0 = -0.413 \pm 0.152$. The quintet-state contributions, in the notation introduced in this paper, are measured to be $B_9/B_0 = -0.148 \pm 0.084$ and $B_{11}/B_0 = 0.002 \pm 0.009$. A calculation is made in which the assumptions of the Rook–Goldfarb treatment are relaxed in order to allow nonvanishing s-wave quintet-state reaction matrix elements. Explicit expressions for the various contributions of these reaction matrix elements to the differential cross section are presented. (auth)

13274 CLUSTER EXPANSION METHOD IN LIGHT NUCLEI. Afnan, I. R. (Univ. of Minnesota, Minneapolis. Univ. of California, Davis). Phys. Rev.; 186: 984-91(20 Oct 1969).

The convergence of the Van Kampen cluster expansion for evaluating the binding energies of light nuclei using a hard-core potential was studied for different forms of the correlation function f. A Jastrow-type trial function was used with a Slater determinant of harmonic-oscillator wave functions. The variational calculations were performed on ^3H and ^4He. For ^3H, where all terms in the expansion were included, good convergence was obtained and the binding energy was in good agreement with the results of the Monte Carlo calculation of Tang et al., indicating a good trial function. In the case of ^4He, the variation with all terms up to and including three-particle correlation gave a binding energy in agreement with the Monte Carlo results and the same convergence as in ^3H. In all the calculations, no subsidiary conditions on the correlation function f(r) were necessary, provided the contribution to the energy from three-particle correlation was included in the variation. Also, the contribution from four-particle correlation was found in all cases to be very small. (auth)

13275 ON ISOSPIN CONSERVATION IN REACTION $^3He(t,d)^4He$. Kim Sun Nam; Osetinskii, G. M.; Sergeev, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR. Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 10: 705-12(Oct 1969). (In Russian).

Deuteron angular distributions from the reaction $^3He + t \rightarrow {}^4He + d$ in the triton energy range 1 to 1.5 MeV are measured. The angular distributions are symmetric around the 90° angle in c.m.s., up to the experimental errors (1 to 1.5%). The symmetry is shown to be due to the isospin conservation in the reaction. The upper bound for the ratio of the isospin-allowed to the forbidden transition amplitudes is obtained to be ~0.02. (auth)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 11817, 12873, 13120, 13249, 13254, 13311, 13334, 13335, and 13426.

13276 (IFA-CRD-39) ON THE POSSIBILITY OF NEW EXPERIMENTS AT LOW ENERGY. Boca, I. (Academia R. S. R., Bucharest. Institutul de Fizica Atomica). 1969. 11p. (In French). Dep. CFSTI (U. S. Sales Only).

The angular distributions, differential cross sections, polarizations, triple-scattering parameters R and A, the spin rotation angle β were calculated for the elastic scattering of protons at 4.5 MeV on carbon using the phase shift analysis. An attempt was made to give a small variation in the phase shifts, and the effect of this variation was studied. For good phase shift accuracy, it is proposed to carry out new experimental determinations at low energy in regard to the Wolfenstein parameters R and A using a polarized proton source. (tr-auth)

13277 (ITF-69-63) CORRECTION OF THE SECOND ORDER OF THE PERTURBATION THEORY TO THE ENERGY OF THE GROUND STATE ^{16}O. Filippov, G. F. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 15p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The correction of the second order of the perturbation theory to the energy of the ground state of ^{16}O is calculated. The expression obtained can be used for the quantitative estimate of the exactness of the binding energy of this nucleus which was found by the variational method on the oscillated wave functions. The contribution to the potential energy ^{16}O from the short-range repelling forces with the given scattering length is found. (auth)

13278 (ITF-69-74) CORRECTION TO THE VARIATION CALCULATION OF THE BINDING ENERGY ^{16}O. Maksimenko, V. N. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 14p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The calculation of the second-order correction of the perturbation theory to the variational binding energy of the nucleus is made for the concrete variant of pair forces which provide for saturation. The allowance for the correction essentially improves the agreement with experiment. The comparison of the calculation results of the correction for the nuclei ^4He and ^{16}O was made. (auth)

13279 (JINR-P-15-4801) INVESTIGATION OF THE PROTON ANGULAR DISTRIBUTIONS FROM THE REACTION $^{12}C(^3He,p)^{14}N$. Schirmer G.; Krivopustov, M. I.; Oehler, H.; Sizov, I. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1969. 19p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Detailed measurements of the angular distributions of three groups of protons from the reaction $^{12}C(^3He,p)^{14}N$, leading to the formation of the residual nucleus ^{14}N in the ground and two first excited states, were performed using an electrostatic generator accelerating ^3He in the energy range 2.2 to 3.6 MeV. (auth)

13280 (ORNL-4441) CARBON NEUTRON ELASTIC- AND INELASTIC-SCATTERING CROSS SECTIONS FROM 4.5 TO 8.5 MeV. Perey, F. G.; Kinney, W. E. (Oak Ridge National Lab., Tenn.). Dec 1969. Contract W-7405-eng-26. 69p. Dep. CFSTI.

Numerical values are given for neutron elastic- and inelastic-scattering cross sections from carbon in the energy range 4.5 to 8.5 MeV. A brief description of the experimental and data-reducing techniques is presented to assist in the evaluation of the data. A comparison was made with other data in this energy region, and fairly good agreement was found, particularly with previous time-of-flight data. The data were also compared with the predictions obtained from the current ENDF/B file of "evaluated" cross sections for carbon. The ENDF/B file was found to reproduce very poorly the data for both elastic and inelastic cross sections. This is not too surprising in view of the rapid changes in the shapes of the cross sections and the paucity of data previously available in this energy region. (auth)

13281 ON THE PROBLEM OF INTERFERENCE OF $^{8*}Be$ LEVELS. Kirilyuk, V. D.; Nikolaev, N. N.; Okun, L. B. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 10: 1081-4(Nov 1969). (In Russian).

The interference between two levels of the excited $^{8*}Be$ nucleus is discussed. It is shown that the experimentally observed dependence of the ratio of intensities of these levels on the $^{8*}Be$ nucleus emission angle may be explained by taking into account the interference with nonresonant background. (auth)

13282 COULOMB FORM FACTORS FOR ^7Li. Wittern, Hans W. (Univ., Tuebingen, Ger.). Z. Phys.; 229: 420-31(1969). (In German).

Using refined clustermodel wave functions the Coulomb form factors for the elastic scattering of electrons as well as the form factors for the inelastic scattering leading to the first and second excited states of ^7Li were calculated. (auth)

13283 POSITIVE PARITY STATES OF ^6Li. Gunye, M. R. (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys.; A139: 686-91(1969).

The energy spectrum of low-lying positive parity states of ^6Li provides a good test for the isospin part of the nuclear interaction. The effective nuclear interactions derived by Elliott et al., directly from NN phase shifts and by Shakin et al., from the Yale potential are used in calculating the ^6Li energy spectrum. The projected Hartree–Fock (HF) calculations for the six-nucleon system are done in the model space of the N = 0, 1, 2 and 3 major shells.

Since the two lowest axially symmetric K = 1 and K' = 0 HF bands come very close in energy, a band-mixing calculation is carried out. The employed interactions underbind ^{6}Li drastically. If the $^3S_1$ matrix elements are increased by about 35%, the experimental binding energy of ^{6}Li can be reproduced. The effect of this increase is examined on the projected spectrum. As in other 0p shell nuclei, the Elliot interaction gives a good account in view of the fact that the binding energy as well as the low-energy spectrum of ^{6}Li can be fairly well reproduced by increasing the $^3S_1$ matrix elements. (auth)

13284 MEASUREMENT OF THE ANALYZING POWER OF THE (d,p) REACTION AND COMPARISON WITH MEASUREMENTS OF PROTON POLARIZATION. Cuno, H.-H.; Clausnitzer, G.; Fleischmann, R. (Univ., Erlangen, Ger.). Nucl. Phys.: A139: 657-72(1969).

The vector analyzing power of the (d,p) stripping reaction was measured with vector polarized deuterons for the nuclei ^{9}Be, ^{10}B, ^{12}C, ^{16}O, ^{28}Si, ^{40}Ca, and ^{90}Zr. The measurements were performed at energies where results for the proton polarization have been published. The vector analyzing powers are compared with the proton polarizations for different l-values and with DWBA predictions. A different behavior for l = 0 and l ≠ 0 transitions was found. (auth)

13285 CROSS-SECTION MEASUREMENTS FOR THE REACTIONS ^{10}B(p,d)^{9}B AND ^{10}B(p,t)^{8}B. Squier, G. T. A. (Queen's Univ., Belfast); Johnston, A. R.; Spiers, E. W.; Harbison, S. A.; Stewart, N. M. Nucl. Phys.; A141: 158-68 (1970).

States of ^{9}B and ^{8}B were studied by measuring differential cross sections for the reactions (p,d) and (p,t) from a ^{10}B target at E_p = 49.5 MeV. Strongly excited states were observed at 0.0, 2.33 and 11.66 MeV in ^{9}B and at 0.0 and 2.29 MeV in ^{8}B. The angular distribution of elastic scattering of 49.5 MeV protons from ^{10}B was also measured and fitted using an optical-model calculation. The distributions of (p,d) and (p,t) cross sections were compared with DWBA predictions and a spin assignment was made for the 2.29 MeV state in ^{8}B. (auth)

13286 COMPARISON BETWEEN VARIOUS APPROXIMATIONS OF THE COLLISION MATRIX FOR THE REACTION ^{6}Li(p,p)^{6}Li. Lejeune, A. (Univ., Liege). Nucl. Phys.; A141: 123-9(1970).

The ^{6}Li(p,p)^{6}Li differential cross section is analyzed with seven different parametrizations of the collision matrix. A one-pole approximation in the complex E-plane is used, together with three different choices of the threshold factors. The result of the introduction of a smooth background term in the approximate collision matrix is analyzed. A one-level approximation in the complex k-plane, with and without background term, is also used. The parameters obtained from these various approximations and the quality of the corresponding fits are compared. Finally, the deviation from unitarity of the approximate collision matrix derived from the analysis is discussed. (auth)

13287 ELECTROMAGNETIC DECAY OF FIRST AND SECOND T = ½ STATES IN ^{19}F. Aitken, J. H. (Univ. of Toronto); Litherland, A. E.; Dixon, W. R.; Storey, R. S. Phys. Lett.; 30B: 473-5 (24 Nov 1969).

The two lowest T = ½ states in ^{19}F were found as strong isolated resonances in the ^{15}N(α,γ)^{19}F reaction. Some significant discrepancies are found between the measured transition strengths and those calculated from shell-model wave functions. (auth)

13288 POLARIZATION OF ^{3}He PARTICLE ELASTICALLY SCATTERED BY ^{12}C NUCLEI. England, J. B. A. (Univ. of Birmingham, Eng.); Harris, R. G.; Watson, L. H.; Worledge, D. H.; Evans, J. E. Phys. Lett.; 30B: 476-7(24 Nov 1969).

The polarization in the elastic scattering of 31.6 MeV ^{3}He particles from ^{12}C at a cms angle of 31.1° has been measured and found to be + 0.014 ± 0.044, indicating a spin-orbit potential in the optical model for ^{3}He scattered by ^{12}C of not greater than 5 MeV. (auth)

13289 ^{11}B + α → α + α + ^{7}Li REACTION AT 28.5 MeV. Fujiwara, Noboru (Kyoto Univ.). J. Phys. Soc. Jap.; 27: 1380-93 (Dec 1969).

Angular correlations between two alpha particles emitted from the reaction ^{11}B + α → α + α + ^{7}Li are studied at the incident energy of 28.5 MeV. The kinematics of the final state were completely determined by measuring the momenta of two alpha particles detected in coincidence. The reaction cross sections are dominated by two body interactions between two alpha particles and between alpha particle and ^{7}Li nucleus. Interferences among two body interactions are observed at the overlapping of two-body resonances. This is discussed to be due to the fact that three bodies interact in the final state. (auth)

13290 THE β-DECAY OF ^{8}B AND 2$^+$ STATES OF ^{8}Be. Clark, G. J.; Treacy, P. B.; Tucker, S. N. (Australian National Univ., Canberra). Aust. J. Phys.; 22: 663-7(Dec 1969). (ANU-P-453).

An abstract of this paper was prepared from the original report appeared as NSA 23: 32900. (Australia)

13291 ZERO DEGREE NEUTRON YIELD FROM THE ^{7}Li(p,n)^{7}Be REACTION NEAR 2.2 MeV. Lefevre, H. W.; Din, G. U. (Australian National Univ., Canberra). Aust. J. Phys.; 22: 669-77(Dec 1969). (ANU-P-449).

An abstract of this paper was prepared from the original report and appeared as NSA 23: 32898. (Australia)

13292 THE ANGULAR DISTRIBUTION OF PROTONS FROM THE ^{12}C(γ,p$_0$)^{11}B REACTION IN THE GIANT RESONANCE REGION. Cannington, P. H.; Dixon, Judith M. (Melbourne Univ., Parkville, Australia). Aust. J. Phys.; 22: 679-85(Dec 1969).

Proton spectra from the ^{12}C(γ,p$_0$)^{11}B reaction were obtained at angles of 30°, 50°, 70°, 90°, 110°, 130°, and 150° using semiconductor detector telescopes. From these spectra the angular distribution of the ^{12}C(γ,p$_0$)^{11}B reaction was determined every 250 keV throughout the excitation energy region between 20 and 27 MeV. The observed energy dependence of the angular distribution is compared with that expected from the collective correlation model description of ^{12}C. (Australia)

13293 PARITY-FORBIDDEN ALPHA DECAY IN ^{16}O. Gari, Manfred (Ruhr-Univ., Bochum, Ger.). Z. Phys.; 231: 412-20 (1970). (In German).

The theory of the parity-nonconserving alpha decays from levels in ^{16}O is developed. Using the weak nucleon-nucleon interaction of Blin-Stoyle and Herczeg and known ^{16}O wave functions modified by short-range correlations via Bethe-Goldstone equation, the irregular alpha widths of the states 2$^-$(8.88 MeV) and 3$^+$(11.05 MeV) were related to known regular widths. The influence by the hard-core of the strong interaction was studied. (auth)

13294 THE ^{12}C(p,2p) AND ^{2}H(p,2p) REACTIONS AT 1.0 GeV. Simpson, W. D. (Brookhaven National Lab., Upton, N. Y.); Friedes, J. L.; Palevsky, H.; Sutter, R. J.; (and others). Nucl. Phys.; A140: 201-3(1970).

The cross sections for the ^{12}C(p,2p) and ^{2}H(p,2p) reactions were measured at 1.0 GeV over a limited range of outgoing energies. The "distorted" momentum distributions were computed for the s- and p-shells of carbon, out to 1.2 fm^{-1}, and are compared to previous measurements and to oscillator wave function distributions. The Fermi momentum distribution in deuterium was measured out to 0.5 fm^{-1}, and compared to the distribution calculated from the Hulthén wave function. (auth)

13295 THEORETICAL INVESTIGATIONS ON THE DECAY OF ^{12}C* INTO THREE α-PARTICLES. Schaefer, K. (Univ., Heidelberg). Nucl. Phys.; A140: 9-22(1970).

An explanation of the decay of ^{12}C*(I$^\pi$ = 2$^+$; 16.1 MeV) formed in the reaction p + ^{11}B → ^{12}C* → 3α at the proton energy E_p = 163 keV seemed to require a special reaction mechanism. It is shown that this resonance is consistent with a sequential process by way of ^{8}Be, if the identity of the α-particles is taken into account. The ideas of a "sequential" and a "statistical" decay are developed from stationary scattering theory. A relation between the scattering operators leads to a simple final-state approximation. On this basis the correlation of the decay for ^{12}C*(I$^\pi$ = 2$^+$; E_p = 163 keV), ^{12}C*(I$^\pi$ = 2$^-$; E_p = 675 keV), and ^{12}C* (I$^\pi$ = 0$^+$; E_p = 2.0 MeV) is calculated. (auth)

13296 SPIN-DEPENDENT EFFECTS IN THE INELASTIC SCATTERING OF HIGH-ENERGY PROTONS. Sherif, H. (Univ. of Washington, Seattle. Univ. of Manchester, Eng.); Blair, J. S. Nucl. Phys.; A140: 33-48(1970).

The polarizations and some cross sections of protons with incident energy in the neighborhood of 155 MeV exciting low-lying states in ^{12}C, ^{24}Mg, ^{28}Si, ^{32}S and ^{40}Ca are analyzed in the framework of collective model DWBA. The crucial ingredient of the calculations is the presence of a deformed spin-dependent interaction of the full Thomas form. With the exception of the 5$^-$ transition in ^{40}Ca, good agreement with the polarization data at forward scattering angles is obtained when this interaction is used; the fits become extremely bad if the Thomas term is ignored or is replaced by a popular approximate form. Comparisons are also made with the polarization predictions of the DWIA method. In general, DWIA fits at forward angles are much less satisfactory than those of the DWBA with the full Thomas term. A discussion of the interrelation between the two methods of calculation is given. (auth)

13297 A STUDY OF DEUTERON SCATTERING ON ^{12}C AND ^{13}C. Guratzsch, H.; Slotta, J.; Stiller, G. (Zentralinstitut fuer

Kernforschung, Rossendorf, Ger.). Nucl. Phys.; A140: 129-40 (1970).

An optical-model analysis is presented of elastic deuteron scattering from ^{12}C and ^{13}C, measured at 13.7 MeV, and of other elastic deuteron scattering data from ^{12}C in the energy range 9 to 14 MeV. Good fits have been obtained with smooth energy dependence of the deduced parameters. DWBA calculations were carried out for inelastic scattering from ^{12}C. (auth)

13298 NUCLEAR STRUCTURE OF ^{18}F. Polsky, L. M.; Holbrow, C. H.; Middleton, R. (Univ. of Pennsylvania, Philadelphia). Phys. Rev.; 186: 966-77(20 Oct 1969).

The nuclear structure of ^{18}F was studied with the reactions $^{17}O(^3He,d)^{18}F$, $^{16}O(^3He,p)^{18}F$, and $^{20}Ne(d,\alpha)^{18}F$ induced with 15-MeV ^3He and 11-MeV deuteron beams. Reaction products were magnetically analyzed and recorded on nuclear emulsions. Angular distributions for the first two reactions were analyzed with distorted-wave Born-approximation predictions, and spectroscopic formation was extracted from the data. The J = 2 level at 3.06 MeV was assigned positive parity and T = 1. The J = 2 level at 3.84 MeV was assigned positive parity, and the 4.12-MeV level was assigned $J^\pi = 3^+$. The three levels at 4.65, 4.74, and 4.96 MeV were identified as having T = 1. The 4.65-MeV level was assigned $J^\pi = 4^+$, and a strong preference is for $J^\pi = 0^+$ and 2^+ assignments for the 4.74- and 4.96-MeV levels, respectively. The results are in good agreement with the theoretical predictions of Kuo and Brown. (auth)

13299 BETA DECAY OF ^{13}B. Jones, K. W.; Harris, W. R.; McEllistrem, M. T.; Alburger, D. E. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev.; 186: 978-83(20 Oct 1969).

The β decay of ^{13}B was studied by means of plastic and NaI(Tl) scintillation detectors. The activity was formed in the $^{11}B(t,p)^{13}B$ reaction using a mechanically chopped beam of 3.0-MeV tritons from a Van de Graaff accelerator. β-γ coincidence measurements confirmed a previously reported β branch to the 3.68-MeV second excited state of ^{13}C. By means of a β-neutron time-of-flight method, β branches to neutron-emitting levels of ^{13}C at 7.5 and 8.86 MeV were observed. The ^{13}C levels in MeV, ^{13}B β branches to these levels in percent, and the corresponding log ft values are ground, 92.1 ± 0.8, 4.02 ± 0.02; 3.68, 7.6 ± 0.8, 4.47 ± 0.05; 7.5, 0.094 ± 0.020, 5.37 ± 0.09; and 8.86, 0.16 ± 0.03, 4.63 ± 0.08. The present results are consistent with recent assignments of $J^\pi = \frac{1}{2}^-$ and $\frac{1}{2}^-$ to the 7.55- and 8.86-MeV ^{13}C levels, respectively. It is suggested that the 7.55-MeV member of the 7.50-7.55-7.68 ^{13}C triplet is the one populated in ^{13}B β decay. The experimental log ft values agree well with theoretical calculations by Cohen and Kurath. (auth)

13300 $^{16}O(\gamma,p)^{15}N$ ANGULAR DISTRIBUTIONS OVER THE ENERGY RANGE 21 TO 33 MeV. Frederick, D. E.; Stewart, R. J. J.; Morrison, R. G. (Ames Lab., Iowa). Phys. Rev.; 186: 992-9(20 Oct 1969).

Energy and angular distributions of photoprotons from ^{16}O were measured using 33-MeV bremsstrahlung from an electron synchrotron. A relative cross section is obtained for photoproton transitions to the ground state of ^{15}N in the energy interval of 27 to 33 MeV. Below 27 MeV, the data include protons from higher-lying levels decaying through excited states, preventing extraction of a valid cross section for this region. Angular distribution data are analyzed in terms of Legendre polynomials. The anisotropy parameter A_2 has the value of -0.55 ± 0.2 over the entire energy range, very near the expected value for d-wave proton emission from a dipole state. The asymmetry parameters A_1 and A_3 both increase in absolute value to a maximum at 30.5 MeV. Observed fluctuations in A_1 and A_2 are well correlated with known resonances in the cross section. The data indicate a broad region of moderate quadrupole strength extending in the upper energy limit of the experiment. (auth)

13301 A STUDY OF T = $\frac{3}{2}$ STATES IN ^{13}N. LeVine, M. J. Parker, P. D. (Yale Univ., New Haven). Contract AT(30-1)3223. Phys. Rev.; 186: 1021-37(20 Oct 1969).

A study of T = $\frac{3}{2}$ states in ^{13}N was carried out by observing these states as resonances in the compound system ^{12}C + p. The lowest T = $\frac{3}{2}$ state was observed as a resonance in the proton elastic scattering at $E_p = 14.231 \pm 0.004$ MeV. A search for additional T = $\frac{3}{2}$ states was carried out by measuring excitation functions for elastic scattering and for several proton-induced reactions over the proton energy range 17.0 to 21.5 MeV; two anomalies were found at $E_p = 17.80$ and 18.459 MeV, whose widths and locations suggest that they might correspond to T = $\frac{3}{2}$ states. In order to obtain the spins, parities, and elastic partial widths for the observed resonances, a program of phase-shift analysis was carried out using optical-model phases plus a single-level dispersion term. Such an analysis of the 14.231-MeV resonance yielded the assignment of $J^\pi = \frac{3}{2}^-$. From a similar analysis, one obtains $J^\pi = \frac{3}{2}^+$ for the 17.80-MeV resonance, while the 18.459-MeV resonance was limited to spin and parity assignments of $\frac{3}{2}^-$ or $\frac{7}{2}^+$. These assignments for the 17.80- and 18.459-MeV resonances, and the observed intensities for their proton decay to the 15.11-MeV state in ^{12}C are consistent with their identification as T = $\frac{3}{2}$ states. Five other resonances, thought to correspond to T = $\frac{1}{2}$ states, were observed at $E_p = 13.035$, 15.220, 17.67, 19.40, and 19.46 MeV and were also analyzed in a similar fashion to yield spin and parity assignments of $\frac{3}{2}^+$, $\frac{7}{2}^+$, $\frac{1}{2}^-$, $\frac{5}{2}^-$, and $\frac{3}{2}^+$, respectively. (auth)

13302 STUDY OF $^9Be(^7Li,p)$, $^9Be(^7Li,d)$, $^9Be(^7Li,t)$, and $^9Be(^7Li,\alpha)$ REACTIONS FROM 5.6 TO 6.2 MeV. Snyder, F. D.; Waggoner, M. A. (Univ. of Iowa, Iowa City). Phys. Rev.; 186: 999-1012(20 Oct 1969).

Absolute differential cross sections at angles ranging from 10 to 170° and at bombarding energies of 5.6, 5.8, 6.0, and 6.2 MeV were measured for the reaction ^9Be + ^7Li, leading to each of the following states: ground and 0.75-MeV states of ^{15}C; ground, 6.10, 6.58 with 6.72, 6.89 with 7.01, 7.34, and 8.32-MeV states of ^{14}C; ground, 3.09, and 3.68 with 3.85-MeV states of ^{13}C; ground, 0.95, 1.64, and 2.62 with 2.72-MeV states of ^{12}B. The yields of the α_0 and α_2 groups at 20° (lab) were measured at 3.3 MeV and at eleven other energies ranging from 5.0 to 6.2 MeV. Absolute cross sections were obtained by comparison of the yields of reaction products to elastic Coulomb scattering. Comparison is made of the total cross-section values with the (2J + 1) rule. The angular distributions for the t_0 and t_1 groups, at each of the bombarding energies, are compared with the predictions of a two-mode (pickup and heavy-particle stripping) direct-reaction process in the plane-wave approximation. (auth)

13303 (n,n') AND (n,2n) REACTIONS IN SEVERAL ELEMENTS AT 14.8 MeV. Mathur, Suresh C.; Buchanan, P. S.; Morgan, I. L. (Texas Nuclear Corp., Austin). Phys. Rev.; 186: 1038-43 (20 Oct 1969).

The neutron-emission cross sections for an incident neutron energy of 14.8 MeV were measured at 90° for Be, B, C, Mg, Si, Ti, V, Mn, Fe, Co, Ni, Cu, Se, Y, Mo, Cd, Sb, Ce, W, and Pb by means of a neutron time-of-flight spectrometer. The experimental data were corrected for neutron multiple scattering. From the experimental inelastic neutron distributions, the distributions for the emission of the first and second neutrons, respectively, were calculated for the medium and heavy nuclei on the basis of the statistical-model treatment of Lang and Le Couteur. The corresponding nuclear temperatures for the emission of the first and second neutrons were also obtained. The calculated inelastic distributions for the emission of the first neutrons were used to obtain the level-density parameters based on the Fermi-gas model. (auth)

13304 ABSENCE OF RECOIL DOPPLER BROADENING OF THE 3367-keV TRANSITION FOLLOWING THE REACTION $^9Be(n_{th},\gamma)^{10}Be$. Wetzel, K. J. (Argonne National Lab., Ill.). Phys. Rev.; 186: 1292-3(20 Oct 1969).

The 3367-keV ground-state γ-ray transition from the reaction $^9Be(n_{th},\gamma)^{10}Be$ shows no Doppler broadening from recoil imparted by emission of γ rays populating this level. This result is consistent with the known lifetime of this level, which is larger than the estimated slowing-down time of the recoil nucleus in the sample medium. (auth)

13305 HIGH-SPIN STATES OF CONFIGURATION $(1d_{\frac{5}{2}})_{5^+}$ AND $(1g_{\frac{9}{2}})_{9^+,0^2}$ STRONGLY POPULATED BY THE (α,d) REACTION. Lu, C. C.; Zisman, M. S.; Harvey, B. G. (Univ. of California, Berkeley). Phys. Rev.; 186: 1086-1103(20 Oct 1969).

The (α,d) reactions on targets of ^{13}C, ^{14}C, ^{15}N, and ^{20}Ne were studied using α-particle beams of 40.1, 46.0, 45.4, and 44.5 MeV, respectively. Angular distributions were obtained. States where the captured proton-neutron pair is in the $(1d_{\frac{5}{2}})_{5^+,0^2}$ configuration coupled to an unperturbed target core are located and possible spin assignments are suggested. These states are ^{15}N, 13.03 MeV $(11/2^-)$, 11.95 MeV $(9/2^-)$; ^{16}N, 5.75 MeV (5+); ^{17}O, 7.74 MeV $(11/2^-)$, 9.14 MeV $(9/2^-)$; ^{22}Na, 1.528 MeV (5+). Separated isotopes ^{52}Cr, $^{54,56}Fe$, $^{58,60,62}Ni$, and $^{64,66,68}Zn$ were used as targets to study the (α,d) reaction with a 50-MeV α-particle beam. States with a probable configuration of $(1g_{\frac{9}{2}})_{9^+,0^2}$ were located. These states are ^{54}Mn, 9.47 MeV; ^{56}Co, 8.92 MeV; ^{58}Co, 6.79 MeV; ^{60}Cu, 5.99 MeV; ^{62}Cu, 4.75 MeV; ^{64}Cu, 4.57 MeV; ^{66}Ga, 2.99 MeV; ^{68}Ga, 2.88 MeV; ^{70}Ga, 2.88 MeV. The residual-interaction energies between the proton and neutron in the configurations $(1d_{\frac{5}{2}})_{5^+,0^2}$, $(1f_{\frac{7}{2}})_{7^+,0^2}$, and $(1g_{\frac{9}{2}})_{9^+,0^2}$ were derived from the excitation energies determined in the present work and previous work on $(1d_{\frac{5}{2}})_{5^+,0^2}$ and $(1f_{\frac{7}{2}})_{7^+,0^2}$ states. For $T_z \neq 0$ nuclide, an "interaction-model" method was proposed to extract the residual-interaction energy. The mean values of the residual-interaction energies are about -3.9, -3.0, and -2.2 MeV, respectively, for the three mentioned configurations. There is a slight decrease

of residual-interaction energy with increasing A. These results are reproduced satisfactorily by conventional shell-model calculations. Both the interaction-model method and Talmi's shell-model calculation method were used to calculate the excitation energies of states with the $(1d_{\frac{5}{2}})_{5+}\rho^2$ configuration. In general, the former method gives better agreement with the experimental results. (auth)

13306 TRITON REACTIONS NEAR 2 MeV: $^{11}B(t,\alpha)^{10}Be$. Silverstein, J. D.; Herling, G. H. (Naval Research Lab., Washington, D. C.). Phys. Rev., 181: 1512-17(May 20, 1969).

α-particle groups from the $^{11}B(t,\alpha)^{10}Be$ reaction were studied using thin self-supporting boron films isotopically enriched to 98% in ^{11}B and surface-barrier detectors. Angular distributions of tritons elastically scattered by ^{11}B and of α particles leaving ^{10}Be in its ground and first-excited states were measured at triton energies ranging from 1.00 to 2.10 MeV. The elastic-scattering data were analyzed with the optical model, and the reaction data were analyzed with the distorted-wave Born approximation for 1 p proton pickup. α-particle potentials having deep wells as opposed to shallow ones were found to provide best fits to the reaction data. The ratio of the spectroscopic factor of the first-excited state in ^{10}Be to that of the ground state, found from the fits to the data, is in reasonable agreement with the value obtained from shell-model calculations. (auth)

13307 ISOSPIN OF THE ^{11}B GIANT RESONANCE. Murray, Kenneth M. (Naval Research Lab., Washington, D. C.). Phys. Rev. Lett.; 23: 1461-3(22 Dec 1969).

The reactions $^{11}B(\gamma,p\gamma')^{10}Be$ and $^{11}B(\gamma,n\gamma')^{10}B$ were observed at bremsstrahlung end-point energies of 24 and 35 MeV. No evidence was found for the existence of the $T = \frac{3}{2}$ component of the giant resonance in ^{11}B. (auth)

13308 DIFFERENTIAL CROSS SECTION AT 154° FOR THE REACTIONS $^6Li(d,\alpha)^4He$ and $^7Li(d,\alpha)^5He$ IN THE ENERGY RANGE 500 TO 1500 keV. Delbrouck-Habaru, J. M.; Dumont, P. D.; Huez, M.; Robaye, G.; Winand, L. (Univ., Liege). Bull. Soc. Roy. Sci. Liege; 38: 240-4(1969). (In French).

The $^7Li(d,\alpha)^5He$ reaction proceeding to the ground state of ^5He was observed, its differential cross section at 154° was measured relative to that of $^6Li(d,\alpha)\alpha$ reaction for deuteron energies from 0.5 to 1.5 MeV. The excitation function shows clearly two resonances at deuteron energies $E_d = 0.780$ and 1.080 MeV which are presumably associated with the states at 17.28 MeV and 17.48 MeV in ^9Be. (auth)

13309 NONCONSERVATION OF ISOSPIN IN DIRECT REACTIONS. Smith, H. Vernon Jr.; Richards, H. T. (Univ. of Wisconsin, Madison). Phys. Rev. Lett.; 23: 1409-10(15 Dec 1969).

New data on the isospin-forbidden reaction $^{12}C(d,\alpha_2)^{10}B(1.74)$ disagree with Noble's proposed direct reaction via a 2^+ doublet in ^6Li. In contrast to other studies, no convincing evidence that direct reactions contribute a major portion of the large isospin-forbidden cross sections was found. (auth)

Nuclear Properties and Reactions, $20 \leq A \leq 89$

Refer also to abstracts 11814, 11885, 12636, 12911, 13250, 13284, 13296, 13298, 13303, 13305, 13348, 13358, 13366, 13375, 13403, and 13429.

13310 (AD-694999) NEUTRON-INDUCED GAMMA-RAY PRODUCTION CROSS SECTIONS FOR SILICON AND TUNGSTEN. Interim Report, May 1968-May 1969. Tucker, W. E.; Buchanan, P. S.; Martin, T. C.; Nellis, D. O.; Williams, G. H. (Nuclear-Chicago Corp., Austin, Tex. Texas Nuclear Div.). 30 May 1969. Contract DASA01-68-C-0128. 112p. (DASA-2333). CFSTI.

Experimental measurements of the differential cross sections for the production of gamma rays in natural silicon and tungsten in the energy range from 5.0 to 11.0 MeV are presented. Theoretical calculations of the production cross sections for silicon, based on statistical theory and the Satchler formalism with modifications by Moldauer, were made, and comparisons of these calculations and other nuclear model calculations with experiment are discussed. (auth) (USGRDR)

13311 (COO-1573-63) NUCLEAR PHYSICS LABORATORY PROGRESS REPORT, NOVEMBER 1, 1968-OCTOBER 31, 1969. (Case-Western Reserve Univ., Cleveland, Ohio. Dept. of Physics). Contract AT(11-1)-1573. 59p. Dep. CFSTI.

CARBON-13—deuteron reactions at 1 to 2.7 MeV, excitation functions for, (E)
COMPUTER PROGRAMS—DETFC modified, for calculating scintillation detector efficiency
IRON-54—neutron elastic and inelastic scattering at 4 to 5.6 MeV, neutron time-of-flight spectra from, (E)
LITHIUM-7—neutron reactions with, search for bound trineutron in fast, (E)
NITROGEN-15—energy levels from resonances in carbon-13 deuteron reactions, compound-nucleus, (E)
RADIATION DETECTORS, SCINTILLATION—efficiency of liquid, computer program for determination of
TRINEUTRONS—search for bound state of, in lithium-7 neutron reactions, (E) (J.W.R.)

13312 (IA-1190, pp 15-32) NUCLEAR PHYSICS. (Israel Atomic Energy Commission, Tel Aviv).

The study of nuclear levels via the $(\gamma\,\gamma')$ reaction, with a source of neutron capture gamma rays as the primary gamma beam, was extended to the low-lying levels of several nuclei. In addition the properties of the highly excited resonant levels between 6 and 9 MeV were analyzed. The investigation of the (n γ) reaction in various titanium isotopes was continued. The results for $^{46}Ti(n\,\gamma)^{47}Ti$ and $^{47}Ti(n\,\gamma)^{48}Ti$ show some evidence for a direct capture mechanism. The high intensities of monoenergetic gamma lines available from neutron capture have made it possible to study small angle Delbruck scattering, which is of special interest in confirming the predictions of quantum electrodynamics. Preliminary results show a cross section in general agreement with theory. Moessbauer sources of metallic selenides were found to give a natural line width for the ^{83}Kr line, with a solid Kr absorber. These sources were used to study the quadrupole splitting in hydroquinone krypton clathrates. Moessbauer studies of frozen solutions of ^{129}I were also continued. A series of studies on the magnetic properties of ferrites and garnets were carried out by measuring the rotation of the angular distribution of reasonantly scattered gamma rays, using a gaseous ^{56}Mn source to obtain β-recoil compensation of the nuclear recoil. (auth)

13313 (TID-25300) DETECTION OF INTERNAL CONVERSION ELECTRONS IN CHARGED PARTICLE SPECTRA. Moore, C. F.; Kulleck, J. G.; Coker, W. R.; Clarkson, R. G.; Kent, J. J.; Courtney, W. J. (Texas Univ., Austin). [1969]. 10p. Dep. CFSTI.

Internal conversion electrons were detected using cooled Si(Li) detectors. No effort was made to separate the scattered electrons and the scattered protons prior to detection. The resolution obtained was typically 4 keV or better. (auth)

13314 THERMAL NEUTRON CAPTURE IN STRONTIUM. Lycklama, H.; Kennett, T. J. (McMaster Univ., Hamilton, Ont.). Nucl. Phys.; A139: 625-56(1969).

The $^{86}Sr(n,\gamma)^{87}Sr$ and $^{87}Sr(n,\gamma)^{88}Sr$ reactions were studied using Ge(Li) and Ge(Li)-NaI(Tl) spectrometers. Energies and intensities were determined for a total of 168 γ-rays. Computer programs were coded to aid in the construction of consistent decay schemes and to search for other levels which may be populated in this reaction. By a comparison of the modes of population and de-excitation of the levels populated in both the β-decay of ^{88}Rb and in the $^{87}Sr(n,\gamma)^{88}Sr$ reaction it was possible to determine the spins and parities of some of the levels in ^{88}Sr. The neutron separation energies for ^{87}Sr and ^{88}Sr were measured to be 8428.2 ± 1.0 and 11113.0 ± 0.6 keV, respectively. (auth)

13315 SINGLE-PARTICLE COMPONENTS OF PARTICLE-VIBRATIONAL STATES IN THE NUCLEI ^{209}Pb, ^{209}Bi, ^{207}Pb, AND ^{207}Tl. Hamamoto, Ikuko (Univ. of Copenhagen). Nucl. Phys.; A141: 1-17(1970).

The fragments of the single-particle strengths, which are carried away from the usual shell-model single-particle states through particle-vibration couplings, are investigated by solving the inhomogeneous differential equations obtained from the Schroedinger equation. The cross sections of one-nucleon transfer reactions are calculated in a DWBA code by using our admixed single-particle wave functions, and the calculated results are compared with experiment. (auth)

13316 SOME NEUTRON-GAMMA RAY ANGULAR CORRELATION STUDIES OF ^{29}P. Calvert, J. M.; Joy, T. (Univ. of Manchester, Eng.). Nucl. Phys.; A141: 33-66(1970).

Neutron-gamma angular correlations were measured for the $^{28}Si(d,n\gamma)^{29}P$ reaction to the first two excited states with the neutron detector on the stripping peak at bombarding energies of 3, 3.4, and 4 MeV. The results obtained at 3 and 4 MeV are in good overall agreement with the spin independent DWBA formalism but not those at 3.4 MeV and departures from this mechanisms are shown to be small at 4 MeV with the neutron detector at 0°. A method is suggested for resolving the $d_{\frac{5}{2}}$ ambiguity in the spin independent DWBA treatment of $l = 2$ stripping to the level of spin

$\frac{5}{2}$. Branching ratios, none of which have been previously reported, have been measured for the second and third excited states. (auth)

13317 HOLE–PARTICLE EXCITATIONS IN ^{58}Ni AND ^{56}Co NUCLEI. Richert, J. (Centre de Recherches Nucleaires, Strasbourg). J. Phys. (Paris); 30: 609-14(Aug-Sep 1969). (In French).

Energy-level calculations for ^{58}Ni and ^{56}Co were performed using shell model techniques and SDI potential. Nuclear levels and reduced transition rates were determined with a basis including 1p–1h core excitations. Agreement with experiment was found for levels at low energies in ^{58}Ni and ^{56}Co, 1p–1h excitations do not however improve greatly earlier results concerning electromagnetic transitions. (auth)

13318 TEST OF THE PAIRING-VIBRATION MODEL IN ^{40}A. Jackson, A. D.; Kuo, T. T. S.; Vergados, J. D. (State Univ. of New York, Stony Brook). Phys. Lett.; 30B: 455-7(24 Nov 1969).

Calculations with a realistic nucleon-nucleon interaction indicate that the pairing-vibration model does not provide a satisfactory description of the levels of ^{40}Ar. (auth)

13319 K = $\frac{1}{2}$ AND K = $\frac{5}{2}$ COMPONENTS IN THE GROUND STATE OF ^{27}Al. Lawergren, B. T. (Columbia Univ., New York); Neilson, G. C.; Honsaker, J. L. Phys. Lett.; 30B: 470-2(24 Nov 1969).

The results of some (^{3}He, n) experiments prove that the ground state of ^{27}Al has K = $\frac{5}{2}$, K = $\frac{1}{2}$ and possibly K = $\frac{3}{2}$ components. Although this rules out the usual Nilsson model with a single K = $\frac{1}{2}$ band, the experiment cannot readily distinguish between the Hartree–Fock model with K-admixtures and the undeformed individual-particle shell model. (auth)

13320 THE MASS AND ENERGY LEVELS OF ^{44}Ti. Simpson, J. J. (Univ. of Toronto); Dixon, W. R.; Storey, R. S. Phys. Lett.; 30B: 478-80(24 Nov 1969).

Energy levels of the self-conjugate nucleus ^{44}Ti were studied with the ^{40}Ca(α,γ)^{44}Ti reaction. A shell-model calculation of levels in ^{44}Ti and ^{44}Sc was performed for comparison purposes. (auth)

13321 STUDY OF ^{40}Ca USING THE REACTION ^{39}K(p,γ_0)^{40}Ca. Heimlich, F.; Mausberg, W. (Univ., Freiburg, i. B.). Z. Phys.; 231: 397-411(1970). (In German).

Excitation functions of the reaction ^{39}K(p,γ_0)^{40}Ca at 0° and 90° were taken in the proton energy range 2.5 to 6.0 MeV corresponding to an excitation of ^{40}Ca between 10.8 and 14.1 MeV. Positions and strengths of several resonances appearing in the excitation functions are given. The structure of ^{40}Ca is compared with predictions from 1 particle–1 hole calculations. (auth)

13322 SPIN ASSIGNMENT FOR THE 4.28-MeV LEVEL IN ^{48}Ca BY MEANS OF THE ^{48}Ca(p,p'γ) REACTION. Bodenmiller, K. H.; Buhl, S.; Kabsch, W. (Univ., Heidelberg). Z. Phys.; 231: 468-74(1970).

The gamma decay mode and the possible spin values of the second excited state of ^{48}Ca(E_x = 4.28 MeV) were investigated by studying the ^{48}Ca(p,p'γ) reaction at an incident proton energy of 10.30 MeV. No ground-state gamma transition was observed. The analysis of the $p_{\frac{1}{2}}$–γ angular correlation, using method II of Litherland and Ferguson, supports the spin assignment I = 0 for this level and excludes all spin values higher than I = 1. (auth)

13323 GAMMA–GAMMA ANGULAR CORRELATIONS IN THE 5.8 MIN ^{51}Ti AND THE 5.1 MIN ^{66}Cu. Hayashi, Takeo; Okano, Kotoyuki; Kawase, Yoichi; Uehara, Shinichi (Kyoto Univ.). J. Phys. Soc. Jap.; 27: 1375-80(Dec 1969).

Angular correlations of the 609–320 keV gamma ray cascade in ^{51}V and of the 833–1039 keV gamma ray cascade in ^{66}Zn have been measured using a multicounter goniometer. In the case of ^{51}V the correlation function is $W(\theta) = 1 + (0.075 \pm 0.024)P_2(\cos\theta) - (0.029 \pm 0.028)P_4(\cos\theta)$, which is compatible with $\delta_{333} = 0.14$ or -6.5 for the spin sequence of $\frac{3}{2}$–$\frac{5}{2}$–$\frac{7}{2}$. In the case of ^{66}Zn the correlation function is $W(\theta) = 1 + (0.30 \pm 0.05)P_2(\cos\theta) + (0.21 \pm 0.07)P_4(\cos\theta)$, which gives $1.57 \leq \delta_{333} \leq 2.27$ for the 2(D,Q)2(Q)0 sequence. The relative intensity ratio between the assumed crossover 1872 keV gamma ray and the 1039 keV gamma ray should be less than 5×10^{-5}. A new 1333 keV gamma ray was found in ^{66}Zn. The relative intensity of it to the 1039 keV gamma ray was determined to be 4.3×10^{-4}. (auth)

13324 LIFETIME MEASUREMENTS ON ^{26}Mg AND ^{29}Si BY DOPPLER SHIFT ATTENUATION. De Kock, P. R.; Koen, J. W.; Mouton, W. L. (Univ. of Stellenbosch, South Africa). Nucl. Phys.; A140: 190-200(1970).

The lifetimes of the lowest bound states of ^{26}Mg and ^{29}Si were determined by means of Doppler shift attenuation measurements. The results are $\tau_m = 300^{+\infty}_{-150}$, 95 ± 25, >5000 and $2100^{+\infty}_{-1000}$ fs for ^{26}Mg (1) through (4) and τ_m = 560 ± 130, 830 ± 260 and 24 ± 14 fs for ^{29}Si (1) through (3), respectively. (auth)

13325 THE DECAY OF ^{82}Rb ISOMERS TO THE LEVELS IN ^{82}Kr. Graeffe, G.; Vaeisaelae, S.; Heinonen, J. (Technical Univ. of Helsinki, Otaniemi, Finland). Nucl. Phys.; A140: 161-72 (1970).

The levels of ^{82}Kr have been studied from the decay of ^{82}Rb isomers by Ge(Li) detectors, a Si(Li) X-ray spectrometer, and coincidence techniques. The 1.3 min ^{82g}Rb was found to populate levels at 777, 1475, 2172, 2480, 2944 and 3186 keV and 6.4 h ^{82m}Rb the levels at 777, 1475, 1821, 1957, 2094, 2427, (2548), 2556, 2649, 2829 and 3012 keV. The possible spins and parities were determined for the excited states in ^{82}Kr based on the log ft values and transition rates. (auth)

13326 EXCITATION ENERGIES IN ^{33}P. Berkowitz, E. H.; Rollefson, A. A.; Berners, E. D.; Browne, C. P. (Univ. of Notre Dame, Ind.). Nucl. Phys.; A140: 173-6(1970).

Precision excitation energy measurements up to 6.56 MeV in ^{33}P are reported. Twenty-five levels are observed with the ^{30}Si(α,p)^{33}P reaction. (auth)

13327 STUDY OF NUCLEI WITH MASSES NEAR 32 WITH THE (^{3}He,d) REACTION. Morrison, R. A. (Argonne National Lab., Ill. Univ. of Chicago). Nucl. Phys.; A140: 97-117(1970).

The (^{3}He,d) reaction has been studied on targets ^{30}Si, ^{31}P, ^{32}S, and ^{34}S. Excitation energies were determined for new states in ^{35}Cl. Angular distributions were measured and absolute cross sections were deduced. Elastic-scattering angular distributions at E(^{3}He) = 15 MeV on ^{31}P and ^{30}Si were measured. The elastic scattering on ^{30}Si was used to determine optical model parameters for use in the entrance channel of a DWBA calculation. Spectroscopic factors and values of the transferred angular momentum were determined by comparing experimental angular distributions with the results of the DWBA calculation. The extracted spectroscopic factors were compared with those from other experiments and with shell-model calculations. (auth)

13328 STATISTICAL EMISSION AND NUCLEAR LEVEL DENSITIES IN (α,n) REACTIONS. Magda, M. T.; Alevra, A.; Lukas, Ingrid R.; Plostinaru, D.; Trutia, Elena; Molea, M. (Inst. for Atomic Physics, Bucharest). Nucl. Phys.; A140: 23-32(1970).

Neutron spectra from (α,n) reactions were studied by the time-of-flight method. Energy distributions of the neutrons were analyzed in the frame of the statistical theory in order to determine the level-density parameter. The values obtained were compared with the predictions of the Fermi gas model and other existing experimental data and their anomalous dependence on the mass number and the bombarding energy was attributed to the contribution of precompound processes. (auth)

13329 NUCLEAR CHARGE RADII OF Al AND Si FROM ELASTIC ELECTRON SCATTERING BETWEEN 25 AND 60 MeV. Bentz, Hans Alfred; Loewenhaupt, Michael; Theissen, Horst (Technische Hochschule, Darmstadt, Ger.). Z. Phys.; 231: 484-90(1970).

Elastic electron scattering cross sections of ^{27}Al and Si (natural isotopic mixture) have been measured relative to carbon. The rms charge radii R_m, deduced with partial wave calculations, are (3.01 ± 0.05) fm for ^{27}Al and (3.06 ± 0.05) fm for Si, in good agreement with results from muonic x-ray energies. The values given are those for a Fermi charge distribution with skin thickness 2.5 fm; harmonic oscillator shell model distributions yield radii smaller by 0.03 fm. The ratio $R_m(^{27}Al)/R_m(Si)$ is 0.984 ± 0.016. (auth)

13330 NUCLEAR CHARGE RADII OF Sc, V, Fe, Co, Ni, Cu, AND Zn FROM ELASTIC ELECTRON SCATTERING AT 60 MeV. Theissen, Horst; Fink, Holger; Bentz, Hans Alfred (Technische Hochschule, Darmstadt, Ger.). Z. Phys.; 231: 475-83(1970).

Elastic electron scattering cross sections have been measured at 60 MeV for scattering angles between 45 and 153 degrees relative to ^{46}Ti(for ^{45}Sc), ^{50}Ti(for ^{51}V), and ^{12}C (for the other nuclei). The following rms radii (in fm) have been deduced with a Fermi-type charge distribution (skin thickness 2.5 fm): ^{45}Sc: 3.52(9); ^{51}V: 3.62(9); Fe: 3.71(11); ^{59}Co: 3.77(5); Ni: 3.78(8); Cu: 3.85(5); Zn: 3.90(5). The present uncertainty of the rms radius of ^{12}C increases the errors given by 0.01 fm. The rms radius differences 0.04(5) fm for ^{46}Ti–^{45}Sc and 0.06(5) for ^{51}V–^{50}Ti were measured directly. (auth)

13331 DEUTERON PRODUCTION IN INTERACTIONS OF 22.8-GeV/c PROTONS WITH Ag AND Br NUCLEI. Shivpuri, R. K. (State Univ. of New York, Buffalo); Bhowmik, B. Phys. Rev.; 186: 1200-4(20 Oct 1969).

The production mechanism of deuterons in high-energy interactions of protons with heavy nuclei was studied. The various features that were studied are the multiplicity, angular distribution, momentum, and transverse momentum of deuterons and protons. The deuteron-to-proton ratio as a function of angle, momentum, and transverse momentum was investigated. The results were compared with the predictions of the various theoretical models. (auth)

13332 HINDRANCE FACTORS OF ALLOWED $1^+ \rightarrow 0^+$ DECAYS IN EVEN–EVEN NUCLEI WITH A = 66 TO 80. Hamilton, J. H. (Vanderbilt Univ., Nashville); Carter, H. K. Phys. Rev.; 186: 1294-5(20 Oct 1969).

Recent work with solid-state detectors on the log ft values of allowed decays from 1^+ ground states to 0^+ and 2^+ states in four even-even nuclei ($66 \leq A \leq 80$) is surveyed. Decays to the first excited 2^+ and second excited 2^+ states are successively hindered over transitions to the 0^+ ground states. Transitions to the excited 0^+ states proceed at rates that are generally hindered even more than those to the second 2^+ levels in these nuclei. Relative B (E2) values from the excited 2^+ states in ^{68}Zn and ^{68}Zn are compared. (auth)

13333 SPIN FLIP IN THE INELASTIC SCATTERING OF 19.6-MeV PROTONS FROM ^{54}Fe AND ^{56}Fe. Hendrie, D. L.; Glashausser, C.; Moss, J. M.; Thirion, J. (Univ. of California, Berkeley). Phys. Rev.; 186: 1188-99(20 Oct 1969).

The spin-flip probability in the excitation of the first 2^+ states in ^{54}Fe and ^{56}Fe was studied at 19.6 MeV using the (p, p'γ) coincidence technique. Differential cross sections were also measured at this energy. The spin-flip data for ^{54}Fe and ^{56}Fe are quite similar, in contrast to asymmetry data from Saclay which show distinct differences between the two nuclei. Collective-model distorted-wave Born-approximation calculations generally underestimate the magnitude of the spin-flip probability at forward angles and predict too little structure. Simple microscopic-model calculations give improved agreement with the spin-flip data only when the terms arising from spin transfer of 1 are significant. These terms had little effect on the predicted cross sections and asymmetries. (auth)

13334 GAMMA-RAY ANGULAR CORRELATIONS AND LIFETIME MEASUREMENTS FOR SOME EXCITED STATES OF ^{21}Ne. Pronko, J. G. (Physikalisches Institut, Freiburg, I B. Yale Univ., New Haven); Rolfs, C.; Maier, H. J. Contract AT(30-1)-3223. Phys. Rev.; 186: 1174-88(20 Oct 1969).

Excited states of ^{21}Ne were studied using the ^{18}O(α, nγ)^{21}Ne reaction at beam energies of 2.9 to 6.9 MeV. The investigation involved the measurement of γ-γ and n-γ angular correlations to obtain spin and multipole-mixing-ratio assignments for five states in ^{21}Ne. In addition, a Ge(Li) detector was used to measure the lifetimes of these states by the Doppler-shift-attenuation method. The investigation resulted in the following assignments for the five states: E_x (keV), J, τ (psec) = 3663.5 ± 2.0, 3/2, 0.12 ± 0.02; 3734.8 ± 1.5, 3/2 or 1/2, <0.067; 3885.5 ± 1.5, 3/2 or 5/2, 0.078 ± 0.027; 4431.3 ± 2.0, 7/2 or 11/2, 0.078 ± 0.027; and 4526.1 ± 1.5, 3/2 or 5/2, <0.067. Some of the results were interpreted in terms of the Nilsson model, and a comparison of the excited states of the ξ = 11 nuclei was made. (auth)

13335 MEAN LIVES, BRANCHING RATIOS, AND EXCITATION ENERGIES OF LEVELS IN ^{20}F BELOW 4 MeV. Hershberger, R. L.; Wozniak, M. J. Jr.; Donahue, D. J. (Univ. of Arizona, Tucson). Phys. Rev.; 186: 1167-73(20 Oct 1969).

The ^{19}F(d, p)^{20}F reaction was used to study the mean lives, branching ratios, and excitation energies of several of the levels of ^{20}F. The Doppler-shift attenuation method was used to obtain the following information concerning the mean lives of the low-lying levels in ^{20}F: $\tau(0.66\ \text{MeV}) = (3.6 \pm 0.7) \times 10^{-13}$ sec, $\tau(0.82\ \text{MeV}) \geq 4.4 \times 10^{-12}$ sec, $\tau(0.98\ \text{MeV}) = (1.3) \times 10^{-12}$ sec, $\tau(1.06\ \text{MeV}) \leq 9.2 \times 10^{-14}$ sec, and $\tau(1.31\ \text{MeV}) = (1.1) \times 10^{-12}$ sec. In addition, upper limits were found for levels at 2.04, 2.19, 2.96, 3.49, and 3.53 MeV. A previously unreported branching ratio of the 2.96-MeV level was found to be (2.96 → 0.0 MeV) 0.24 ± 0.03, (2.96 → 0.66 MeV) 0.14 ± 0.02, and (2.96 → 0.82 MeV) 0.62 ± 0.06. A value of 3^+ is suggested for the spin and parity of the 0.66-MeV level. (auth)

13336 POSITRON DECAYS OF ^{42}Ti AND ^{38}Ca. Gallmann, A.; Aslanides, E.; Jundt, F.; Jacobs, E. (Laboratoire de Physique Nucleaire et d'Instrumentation Nucleaire, Strasbourg). Phys. Rev.; 186: 1160-6(20 Oct 1969).

The positron decay of ^{42}Ti was investigated using the ^{40}Ca(^{3}He, n) reaction with a natural calcium target. A strong 610.7 ± 0.5-keV γ ray with a half-life $T_{1/2} = 0.202 \pm 0.005$ sec is attributed to a positron branch to the 611-keV level of ^{42}Sc. A weak 2222 ± 2-keV γ ray was observed, which corresponds to a positron branch to the 2223-keV level of ^{42}Sc. Using this measured half-life and the β-decay energies, the branching ratios are calculated from β-decay systematics to be $r^+_{\beta 0} = (44.1 \pm 1.2)\%$, $r^+_{\beta 1} = (55.2 \pm 1.2)\%$, and $r^+_{\beta 2} = (0.7 \pm 0.3)\%$. The log ft values 3.179 ± 0.015 and $4.36^{+0.11}_{-0.14}$ establish $J^\pi = 1^+$ for both the 611- and the 2223-keV states of ^{42}Sc. The positron decay of ^{38}Ca was investigated using the ^{36}Ar(^{3}He, n) reaction. The half-life 0.439 ± 0.012 sec was measured for this decay. In addition to the strong Gamow-Teller transition feeding the 1695-keV level of ^{38}K, a weak 3210 ± 2-keV γ-ray line was observed which is tentatively attributed to a transition from the 3337-keV level in ^{38}K fed by a $(0.6 \pm 0.2)\%$ β^+ branch of ^{38}Ca. Its log ft $(3.90^{+0.10}_{-0.13})$ then establishes the $J^\pi = 1^+$ assignment for this state. (auth)

13337 (d,t) AND (d,^{3}He) REACTIONS ON THE CALCIUM ISOTOPES. Yntema, J. L. (Argonne National Lab., Ill.). Phys. Rev.; 186: 1144-60(20 Oct 1969).

The ^{42}Ca(d, t)^{41}Ca, ^{43}Ca(d, t)^{42}Ca, ^{44}Ca(d, t)^{43}Ca, ^{46}Ca(d, t)^{45}Ca, ^{48}Ca(d, t)^{47}Ca, ^{42}Ca(d, ^{3}He)^{41}K, ^{43}Ca(d, ^{3}He)^{42}K, and ^{44}Ca(d, ^{3}He)^{43}K reactions were investigated at an incident deuteron energy of 22 MeV. The angular distributions were compared with distorted-wave calculations and the spectroscopic strength was extracted. The larger fraction of the $d_{3/2}$ strength was found in the $3/2^+$ states at 2.02, 0.99, 1.89, and 2.60 MeV in ^{41}Ca, ^{43}Ca, ^{45}Ca, and ^{47}Ca, respectively. Strong s-wave transitions were observed to levels at 1.96, 2.40, and 2.60 MeV in ^{43}Ca, ^{45}Ca, and ^{47}Ca, respectively. The $1/2^+$ hole state at 2.67 MeV in ^{41}Ca was found to be less pure than the other strong s- and d-hole states. Similarly, a pronounced fractionation of the s-hole configuration among the levels at 0.982, 1.273, 1.595, and 2.73 MeV was found in ^{41}K—in contrast with the other even-parity hole states in ^{41}K and ^{43}K (including the $1/2^+$ level at 0.56 MeV), which are rather pure. This splitting is attributed in part to the interaction of another $1/2^+$ state with the s-proton hole state. Some $2p_{3/2}$ admixture was observed in each of the neutron pickup reactions and a $2p_{3/2}$ admixture was seen in ^{48}Ca. Comparison between the relative intensities of the transitions to the $3/2^-$ levels in ^{41}Ca and ^{43}Ca and those of the (d, p) reactions to those levels suggest the admixture of core-excited configurations in the ground state of ^{42}Ca and ^{44}Ca. The upper limit for the $f_{7/2}$-proton admixture in the ground state of ^{42}Ca was found to be $^2C\,S \leq 0.4$. The second 0^+ state in ^{42}Ca is excited with about 10% of the strength of the first 0^+ state. The strength of the transitions to the 0^+ and 2^+ states together with those of the 4^+ and 6^+ states is significantly smaller than expected from simple shell-model considerations and suggests that other levels with $(f_{7/2})^2$ configurations exist in ^{42}Ca at higher energies. The l = 0 transitions to states in ^{42}Ca rarely mix with the l = 2 transitions. There is a fairly good correspondence between the s-hole states and the 3^- states. Application of the sum rule and comparison with the other reactions suggest that the total spectroscopic factor for $s_{1/2}$, T = 1 pickup is considerably smaller than would be expected from a closed 2s shell. The four lowest levels in ^{42}K have l = 2 transitions and the strengths are in agreement with a 2^-, 3^-, 4^-, 5^- sequence. In addition, s-proton hole states in ^{42}K were observed at 1.2, 2.01, and 2.13 MeV. A possible $d_{3/2}$-hole state was found in ^{41}K at an excitation energy of 3.566 MeV. (auth)

13338 GAMMA DECAY OF ANALOG RESONANCES IN THE ^{49}Ti(p,γ)^{49}V REACTION. Legg, J. C.; Megli, D. G.; Abraham, D. R.; Ellsworth, L. D.; Hechtl, S. (Kansas State Univ., Manhattan). Contract AT(11-1)-1766. Phys. Rev., 186: 1138-43(20 Oct 1969).

The γ decays of four prominent resonances in the ^{49}Ti(p,γ)^{49}V reaction were studied using an 18-cc Ge(Li) detector. Gamma-ray angular distributions were obtained at resonant energies of 1.007, 1.013, 1.361, and 1.387 MeV. From these data, relative intensities, mixing ratios, and probable spins for resonant and secondary states are determined. The decay of the resonances indicate that the M1 γ decay of the analog resonances is strongly inhibited. It is found that the prominent resonance at 1.387 MeV is probably not an analog resonance, indicating that the identification of resonances as analog resonances simply on the basis of their strength in the (p,γ) reaction is highly questionable. (auth)

13339 VARIOUS NUCLEAR-POTENTIAL DESCRIPTIONS OF THE ELASTIC SCATTERING OF ^{16}O + ^{40}Ca. Eck, J. S.; Lasalle, R. A.; Robson, D. (Florida State Univ., Tallahassee). Phys. Rev.; 186: 1132-7(20 Oct 1969).

Excitation functions for the elastic scattering of ^{16}O by ^{40}Ca were measured in 0.5-MeV steps at cm angles 59.1, 90.0, 123.2, and 144.13° in the energy range (lab) 23 to 42 MeV. At the laboratory energies 38, 40, and 42 MeV, angular distributions were obtained between 25–130° (cm) in 2.5° steps. The data were analyzed using an optical-model-type calculation for various potential forms. The standard optical-model potential using a real and imaginary potential with a Woods–Saxon form factor was insufficient to yield a complete description of the data. A recent exten-

sion of the optical model to include an l-dependent absorption term gave a better description of the experimentally measured cross sections. The inclusion of a short-range repulsive core in the nuclear potential did not greatly alter the calculated cross sections. A semiclassical rainbow-scattering analysis was also performed in order to obtain better insight into the various optical model parameters, and also to determine the importance of the tail region of the nuclear potential in the $^{16}O-^{40}Ca$ elastic scattering. (auth)

13340 HALF-LIFE OF ^{53}Mn. Hohlfelder, Jacque J. (Univ. of Minnesota, Minneapolis). Phys. Rev.; 186: 1126-31 (20 Oct 1969).

The half-life of ^{53}Mn was calculated from the measured ^{53}Mn activity in a manganese sample extracted from a fragment of the Canyon Diablo iron meteorite and from the manganese sample's measured isotopic ratio $^{53}Mn/^{55}Mn$. The half-life of ^{53}Mn determined in this work, 10.8 ± 4.5 million years (3σ error), and the measured manganese sample activity are compared with theoretically and experimentally determined ^{53}Mn half-lives and ^{53}Mn activities measured in other meteorites. (auth)

13341 ELASTIC AND INELASTIC ELECTRON SCATTERING FROM ^{55}Mn. Theissen, H. (Yale Univ., New Haven); Peterson, R. J.; Alston III, W. J.; Stewart, J. R. Contract AT(30-1)2726. Phys. Rev.; 186: 1119-25(20 Oct 1969).

Elastic and inelastic electron scattering from ^{55}Mn was studied for incident electron energies between 25 and 60 MeV and scattering angles in the range 69 to 149°. A partial-wave analysis of the elastic scattering data yielded a ground-state rms radius equal to 3.68 ± 0.11 F, in good agreement with the muonic x-ray result. From inelastic scattering which covered excitation energies up to 3.5 MeV, reduced radiative-transition probabilities for excitations to levels at 0.98, 1.53, 1.88, 2.29, and 3.05 MeV were deduced by a distorted-wave analysis. The transition probabilities are compared to those obtained from heavy-particle scattering and γ resonance fluorescence. (auth)

13342 ELASTIC AND INELASTIC SCATTERING OF PROTONS FROM KRYPTON. Kim, H. J.; Bair, J. K.; Jones, C. M.; Willard, H. B. (Oak Ridge National Lab., Tenn.). Phys. Rev.; 186: 1110-18(20 Oct 1969).

Elastic and inelastic scattering of protons from krypton was investigated for the bombarding energy range 3.6 to 5.4 MeV. Resonances were observed in the elastic scattering and in the inelastic scattering to the first 2^+ (0.877 ± 0.011 MeV) state in ^{84}Kr. The resonant energies are (as obtained from the inelastic scattering yield curves) 4.990 ± 0.017 and 5.277 ± 0.017 MeV. Resonance parameters obtained by the use of the optical model with an added isolated resonance term suggest that these resonances are due to isobaric analog states of hitherto unreported low-lying states of ^{85}Kr with 1.23-MeV ($J^\pi = 3/2^+$ or $5/2^+$) and 1.52-MeV ($J^\pi = 1/2^+$) excitation energies. These excitation energies have an associated maximum uncertainty of ±100 keV. Angular distributions of the inelastic protons from the $^{84}Kr(p, p')^{84}Kr$ (0.877 MeV) measured on these resonance peaks show interference effects. Isobaric analogs of those states strongly excited via the $^{86}Kr(d, t)^{85}Kr$ neutron pickup reaction were not observed in the present investigation, thus confirming their "neutron-hole" nature. Inelastic scattering to the first 2^+ (0.771 ± 0.011 MeV) and the second 2^+ (1.470 ± 0.007 MeV) states of ^{82}Kr was studied for the bombarding energy range 4.9 to 5.4 MeV, the yield of protons going to the first excited state resonates at 5.34 MeV. If one assumes that this resonance is a manifestation of an analog of a low-lying state of ^{83}Kr, the excitation energy is 1.89 MeV, again with a maximum uncertainty of about ±100 keV. No resonance is seen for the yield to the 1470-keV second excited state. The effect of the compound-nuclear-reaction mechanism on the inelastic cross sections has been investigated. Theoretical off-resonance inelastic cross sections calculated by the Hauser–Feshbach formalism of statistical compound-nuclear reactions agree with the experimental results quite satisfactorily. (auth)

13343 $J = 0^+$ STATES IN ^{40}Ca AND ^{42}Ca. Federman, P.; Pittel, S. (Franklin Inst., Swarthmore, Pa.). Phys. Rev.; 186: 1106-9(20 Oct 1969).

An attempt was made to understand the low-lying spectra of 0^+ states in ^{40}Ca and ^{42}Ca, without having to introduce configurations with a very high number of holes. The analysis of ^{40}Ca includes 0p-0h, 2p-2h, and 4p-4h configurations, with the particles and holes restricted to the $1f_{7/2}$ and $1d_{3/2}$ orbitals, respectively. The effects of higher orbitals are simulated by lowering the $1f_{7/2}$-$1d_{3/2}$ single-particle splitting. The model reproduces all the known 0^+ levels in ^{40}Ca with remarkable accuracy. The calculation in ^{42}Ca includes only the 2p-0h and 4p-2h configurations, and the same matrix elements used in the analysis of ^{40}Ca. Again all the known 0^+ states are reproduced, including the group between 5.85 and 6.70 MeV. These states are predominantly of 4p-2h nature, with the four particles coupled to their maximum possible isospin. (auth)

13344 EXCITATION OF GIGANT RESONANCE IN ^{32}S BY ELECTRON SCATTERING. Gulkarov, I. S.; Afanas'ev, N. G.; Khomich, A. A.; Khvastunov, V. M.; Afanas'ev, V. D.; Savitskii, G. A.; Shevchenko, N. G. (Physical-Technical Inst., Kharkov). Yadern. Fiz.; 10: 694-8(Oct 1969). (In Russian).

Spectra of inelastically scattered electrons on the ^{32}S nucleus in the excitation energy region 13 to 31 MeV are measured. The giant dipole resonance in ^{32}S has the mean excitation energy 20.0 ± 0.3 MeV and the half-width 6.3 ± 0.6 MeV. The giant resonance form factor is obtained. The fine structure observed is compared with the data of other measurements. (auth)

13345 THE g FACTOR OF THE 184-keV STATE OF ^{67}Zn. Bozek, E. (Inst. of Nuclear Physics, Krakow); Broda, R.; Golczewski, J.; Hrynkiewicz, A. Z.; Kulessa, R.; Rybicka, M.; Szymczyk, S.; Walus, W. Acta Phys. Pol.; 36: 1065-9(Dec 1969).

The angular correlation coefficient $A_2 = -0.2031 \pm 0.0018$ for the 209 – 184 keV γ–γ cascade in ^{67}Zn was obtained. The derived admixture of E2 in the 209-keV transition is equal to $Q(E2) < 0.2\%$. The half-life of the 184-keV state was remeasured as $T_{1/2} = 1.03 \pm 0.05$ ns. The g-factor of the 184-keV state was determined by the method of the integral rotation of the angular correlation in an external magnetic field. $g = 0.33 \pm 0.04$ was obtained. A new method of data handling was applied for g-factor calculation which can be used in the case of poorly resolved gamma cascades. (auth)

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Refer also to abstracts 11549, 11615, 11628, 12348, 12389, 13303, 13310, 13312, 13313, 13328, and 13331.

13346 (CEA-CONF-1369) APPLICATION OF NEW FAST CHEMICAL SEPARATIONS IN THE DETERMINATION OF THE CHARGE DISTRIBUTION IN LOW-ENERGY FISSION. Blachot, J.; Carraz, L. C.; Cavallini, P.; Gadelle, A.; Moussa, A. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [1969]. 12p. (In French). (CONF-690708-5). Dep. CFSTI (U. S. Sales Only).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria.

Rapid chemical methods of separation were developed. The first was based on the recoil of fission products in $RuCl_3$, then heating the mixture to 600°C in a tube with a temperature gradient. It is possible in this way to separate, with good yield and high radiochemical purity, the following elements in less than one minute: Te, Nb, Zr, Mo, and Sb. The second method is based on recoil in naphthalene and sublimation in a tube with a temperature gradient. This method makes possible the isolation of I and Br. Also the method based on the formation of hydrides by the action of an acid solution on zinc has been applied to the separation of Sb. These three rapid methods were used for the determination of the independent fractional or cumulative yields of the following fission products: ^{96}Nb, ^{97}Nb, ^{98}Nb, ^{99}Nb, ^{100}Nb, ^{127}Sb, ^{128}Sb, ^{129}Sb, ^{130}Sb, ^{131}Sb, ^{134}I, and ^{136}I. (tr-auth)

13347 (LA-4285) NEUTRON INDUCED FISSION CROSS SECTIONS FOR ^{235}U FROM THE PERSIMMON EVENT. Cramer, J. D.; Bergen, D. W. (Los Alamos Scientific Lab., N. Mex.). Oct 1969. Contract W-7405-eng-36. 24p. Dep. CFSTI.

The $^{235}U(n,f)$ cross section was measured for incident neutron energies of from 20 to 1000 eV relative to the $^6Li(n,\alpha)T$ and $^3He(n,p)T$ reaction cross sections. Neutron energies were separated by time of flight from the single burst of an underground nuclear detonation in an ~300-m evacuated flight path. Results of this experiment are compared with previous measurements of the $^{235}U(n,f)$ cross section. (auth)

13348 (NYO-2028-4) NUCLEAR REACTIONS IN LIGHT NUCLEI AND MOESSBAUER STUDIES. (Johns Hopkins Univ., Baltimore, Md. Dept. of Physics). Oct. 1969. Contract AT(30-1)-2028. 144p. Dep. CFSTI.

BORON-12—nuclear magnetic resonance in beryllium, copper, and molybdenum, (E)
GAMMA SPECTROMETERS—design and performance of Compton lithium-drifted germanium, for linear polarization measurements
IRON-57—energy level at 14.4 keV, NMR transition of, (E)
MOESSBAUER EFFECT—magnetically induced rf sidebands in

SAMARIUM-154—energy level of, magnetic and quadrupole moments of first 2^+, (E)
—isomer shift in, determination using Moessbauer effect, (E)
URANIUM-238—Moessbauer effect in uranium dioxide, (E)
(J.W.R.)

13349 SPONTANEOUSLY FISSIONING ISOMERS IN U, Np, Pu, AND Am ISOTOPES. Lark, N. L.; Sletten, G.; Pedersen, J.; Bjoernholm, S. (Univ. of Copenhagen). Nucl. Phys.; A139: 481-500(1969).

Spontaneously fissioning isomers have been discovered and assigned to ^{236}U, ^{239}Np, ^{236,237,240,241,242,243}Pu and ^{239,241}Am. They were produced by irradiation of thin targets with 9–14-MeV protons or deuterons. Fission-in-flight of recoiling reaction products was observed with plastic foils as fission track detectors. The half-lives range from 9 ns to 1.5 μs and the formation cross sections from 12 μb to 0.13 μb. The proton excitation functions for the ^{239m}Am, ^{241m}Am and ^{236m}Pu isomeric states show threshold behavior typical of a (p,2n) reaction. The differences E_{II} in thresholds for the ground state and the isomeric state, respectively, are: E_{II} (^{239m}Am) = 2.9 ± 0.1 MeV, E_{II} (^{241m}Am) = 2.5 ± 0.1,MeV, E_{II} (^{236m}Pu) = 4.1 ± 0.2 MeV. An isomer ratio of 2.2 × 10^{-5} for ^{236m}Pu was obtained from the measured yield of the isomer and of the ^{236}Pu ground state. Other isomer ratios were deduced using calculated ground-state yields. The variations in half-lives and excitation energies with Z and N are discussed and compared to theoretical calculations of the barrier shapes. (auth)

13350 STRUCTURE IN THE GIANT RESONANCE OF ^{108}Pd AND OF ^{110}Pd. Deague, T. K.; Muirhead, E. G.; Spicer, B. M. (Univ. of Melbourne). Nucl. Phys.; A139: 501-12(1969).

The ^{108}Pd photoneutron cross section has been measured from threshold to 24.5 MeV by direct neutron detection. The ^{108}Pd(γ,p) and ^{110}Pd(γ,n)^{109m}Pd cross sections have been measured from threshold to 29 MeV by counting residual γ-activity. The dynamic collective model predictions of Huber for ^{108}Pd and ^{110}Pd are in reasonable agreement with these cross sections in giant resonance region, but a large amount of observed strength at energies less than 14 MeV and greater than 20 MeV is not accounted for by the model. The relative strengths of the proton and neutron production cross sections in ^{108}Pd are shown to be consistent with Morinaga's concept of an isospin-split giant resonance. Similar agreement is demonstrated for ^{103}Rh, ^{90}Zr and ^{65}Cu. However, the relative strengths in ^{58}Ni are found to be inconsistent with this concept. (auth)

13351 FRAGMENT ENERGY CORRELATION MEASUREMENTS FOR THE PROTON INDUCED FISSION OF ^{226}Ra. Konecny, E. (Technische Hochschule, Munich); Noerenberg, W.; Schmitt, H. W. Nucl. Phys.; A139: 513-22(1969).

The yield, average total fragment kinetic energy, and width of the total fragment kinetic energy distribution have been determined as functions of fragment mass from two parameter fragment energy correlation experiments for the proton-induced fission of ^{226}Ra. Results were obtained for proton energies E_p = 9, 11, and 13 MeV. The average total fragment kinetic energy is found to decrease slowly with increasing compound nucleus excitation energy. The observed rate of decrease is generally largest for fragment pairs in which one fragment is near doubly magic, i.e., for heavy fragment mass ≈132 a.m.u. Increase in relative yield of the symmetric peak of the mass distribution with increasing excitation energy is once again observed. These and other observations are interpreted in terms of the previously proposed two-component hypothesis together with molecular model considerations including the assumption that the number of quasi-particle excitations at scission is determined by the excitation energy at the saddle point. (auth)

13352 γ–γ ANGULAR CORRELATIONS IN ^{123}Te. Sergolle, H.; Vanhorenbeeck, J. (Institut de Physique Nucleaire, Orsay, France). Nucl. Phys.; A139: 554-62(1969). (In French)

The γ–γ angular correlations have been performed in ^{123}Te isotope, from the γ-ray spectrum in coincidence with the 158.7 keV, $3/2^+ \rightarrow 1/2^+$ transition. The $A_2^{(1)}$ factor is measured for 5 transitions between 5 levels and the first excited state $3/2^+$. The spin of the levels at 439.2, 505.2, 687.7, 697.1 and 783.4 keV (respectively 3/2, 5/2, 3/2, 1/2 and 3/2 or 5/2) and the mixing parameter of the 280.6 and 346.3 keV transitions are deduced. (auth)

13353 COULOMB EXCITATION OF ^{113}In AND ^{115}In WITH OXYGEN IONS. Bernstein, E. M.; Seaman, G. G.; Palms, J. M. (Los Alamos Scientific Lab., N. Mex.). Nucl. Phys.; A141: 67-74(1970).

The γ-ray spectra emitted following Coulomb excitation of ^{113}In and ^{115}In with 40 and 50 MeV oxygen ions were studied with a Ge(Li) detector. The levels excited are as follows: ^{113}In–1026, 1132, 1176, 1347 keV; ^{115}In–944, 1076, 1131, 1289, 1448 keV. A striking correspondence is noted between the levels observed in the two isotopes. (auth)

13354 EXPERIMENTAL INVESTIGATION OF THE DECAY ^{223}Ra → ^{219}Rn. Krien, K.; Guenther, C.; Bowman, J. D.; Klemme, B. (Univ., Bonn). Nucl. Phys.; A141: 75-96(1970).

The conversion electron and gamma spectra in the decay ^{223}Ra → ^{219}Rn were investigated with singles and coincidence techniques. Multipolarities of γ-transitions are derived from conversion electron intensities and α–γ-angular correlations. Spin assignments for the lowest 7 states are proposed. The half-life of the 127 keV state has been determined as $T_{\frac{1}{2}}$ = 402 ± 20 ps. An attempt is made to interpret the results in terms of the Nilsson model. (auth)

13355 A STUDY OF THE NUCLEAR STRUCTURE OF THE ODD TIN ISOTOPES BY MEANS OF THE (p,d) REACTION. Cavanagh, P. E.; Coleman, C. F.; Hardacre, A. G.; Gard, G. A.; Turner, J. F. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Phys.; A141: 97-122(1970).

Experimental aspects and detailed experimental results of an investigation by means of the (p,d) reaction of the energy levels of the odd tin isotopes from ^{111}Sn to ^{123}Sn, using a sonic spark chamber as a position sensitive detector in the focal plane of a 180° double-focusing magnetic spectrograph, are given. The measurements were carried out at a bombarding energy of 30 MeV and with an overall resolution of from 55 → 70 keV FWHM, and cover an excitation range ≈4 MeV. The angular distributions were obtained with statistical errors usually ≲3% for the major levels, and showed a very smooth variation with mass number. Typically one line contained 80% or more of the strength for each of the major single-particle configurations, except for the $d_{\frac{5}{2}}$ configuration, which appeared as a doublet in ^{117}Sn and heavier isotopes. At forward angles the d-angular distributions showed a significant J-dependence, which was used in assigning J-values to the weaker d-levels. Evidence for the excitation by pickup of what appear to be systematic sets of collective levels is presented, including one set with l = 1. (auth)

13356 THE (n,α) REACTION ON SAMARIUM AND NEODYMIUM ISOTOPES INDUCED BY THERMAL NEUTRONS. Okamoto, Koichi (Japan Atomic Energy Research Inst., Ibaraki, Japan). Nucl. Phys.; A141: 193-210(1970).

The (n,α) reaction was investigated on ^{147}Sm, ^{149}Sm, ^{143}Nd, and ^{145}Nd with thermal neutrons, and the effective cross sections were obtained. The reaction cross sections at the neutron energy of 0.0253 eV (2200 m/sec values) were deduced from the observed neutron spectrum. The reaction cross sections for the ^{149}Sm(n,α) ^{146}Nd reaction at 0.0253 eV are 5.0 ± 0.5 mb and 23.5 ± 3.7 mb for alpha transitions to the ground and to the first excited states of ^{146}Nd, respectively. The disagreement of the partial cross section for an alpha transition to the first excited state of ^{146}Nd with other reported values is discussed. The reduced alpha widths are also obtained. (auth)

13357 HIGH-SPIN STATES IN ODD Xe NUCLEI. Rezanka, I.; Kerek, A.; Luukko, A.; Herrlander, C. J. (Research Inst. for Physics, Stockholm). Nucl. Phys.; A141: 130-44(1970).

Levels of odd Xe isotopes (A = 125–129) have been studied in Te (α,3n) reactions. Measurements of γ-ray intensities, angular distributions, and excitation functions have been made. The level structure of high-spin states in Xe isotopes is discussed. (auth)

13358 PRECISE COMPARISON AND MEASUREMENT OF GAMMA-RAY ENERGIES WITH A Ge(Li) DETECTOR. I. 50 TO 420 keV. Greenwood, R. C.; Helmer, R. G.; Gehrke, R. J. (Idaho Nuclear Corp., Idaho Falls). Nucl. Instrum. Methods; 77: 141-58(1970).

A Ge(Li) gamma-ray spectrometer was used to make precise comparisons of the reported energies of a number of gamma-rays that are useful for energy calibration. The results indicate that in the energy region studied, below 420 keV, this spectrometer is capable of a relative precision of about 5 eV. The energies of the forty lines compared appear to be consistent to within this precision or their quoted uncertainties (i.e., 1 to 10 eV). Comparisons of energies reported relative to the x-ray energy scale (i.e., the $K\alpha_1$ x-ray of tungsten) and to the m_0c^2 scale (i.e., 511.006 keV), indicate that these scales are consistent to within (17 ± 28) ppM. Energies were also measured for gamma-rays emitted in the decay of the isotopes ^{109}Cd, ^{133}Ba, ^{153}Gd, ^{57}Co, ^{75}Se and ^{113}Sn. (auth)

13359 THE PROTON DECAY OF THE $g_{\frac{9}{2}}$ ANALOGUE RESONANCE IN ^{207}Bi. Solf, J.; Moore, C. Fred; Grosse, E.; von Brentano, P. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Phys.; A139: 523-33(1969).

Angular distributions for the inelastic proton decay of the $g_{\frac{9}{2}}$ isobaric analog resonance in ^{207}Bi have been measured. A charac-

teristic group of levels in ^{206}Pb is found to be strongly excited in the resonance and these levels are interpreted as neutron particle-hole states with a $g_{\frac{9}{2}}$ particle. The levels in the group were very close lying and the detector resolution of about 15 keV was not always sufficient to separate the levels. The separation was, however, very much improved with the help of a spectrum unfolding program. Most of the angular distributions are symmetrical about 90° and they were fitted with a series of Legendre polynomials and integrated widths $\Gamma(g_{\frac{9}{2}} \rightarrow I)$ for the decay of the $g_{\frac{9}{2}}$ resonance to these levels were deduced. (auth)

13360 ANOMALOUS POPULATION OF THE GROUND-STATE ROTATIONAL BAND OF ^{174}Hf IN THE ^{172}Yb(α,2nγ) ^{174}Hf REACTION. Mills, S. J.; Rautenbach, W. L. (CSIR, Pretoria). Phys. Lett.; 30B: 481-2(24 Nov 1969).

It is shown that a special nuclear-structure effect in the de-excitation of the ^{174}Hf nucleus sets in at an excitation energy of approximately 6.5 MeV, and completely alters the process by which the levels in the ground-state rotational band are normally populated in (α,xnγ) reactions. (auth)

13361 PRODUCTION OF SPONTANEOUS FISSION ISOMERS IN THE REACTIONS OF ^{237}Np WITH 30 TO 70 MeV ^{4}He. Natowitz, J. B.; Archer, J.K. (Texas A and M Univ., College Station). Contract AT-(40-1)-3924. Phys. Lett.; 30B: 463-4(24 Nov 1969).

Mica detectors were employed to observe spontaneous fission isomers produced in the reactions of ^{237}Np with 30 to 70 MeV ^{4}He projectiles. Three narrow peaks in the excitation function are tentatively identified as corresponding to the production of ^{238m}Am, ^{236m}Am, and ^{235m}Am. (auth)

13362 EXPERIMENTS ON PARITY NON-CONSERVATION IN NUCLEAR GAMMA TRANSITIONS OF ^{181}Ta AND ^{175}Lu. Vanderleeden, J. C.; Boehm, F. (California Inst. of Tech., Pasadena). Contract AT(04-3)-63. Phys. Lett.; 30B: 467-9(24 Nov 1969).

The circular polarization of γ-rays from unpolarized sources of ^{181}Hf and ^{175}Yb was measured with a Compton polarimeter and a current integrating Ge-detector system. The results are $P_\gamma = (-3.8 \pm 1.3) \times 10^{-6}$ for the 482-keV transition in ^{181}Ta, and $P_\gamma = (+6.2 \pm 0.8) \times 10^{-5}$ for the 396-keV transition in ^{175}Lu. (auth)

13363 INELASTIC SCATTERING OF POLARIZED PROTONS THROUGH ISOBARIC ANALOG RESONANCES IN ^{91}Nb. Graw, G.; Clausnitzer, G.; Clement, H.; Wienhard, K.; Fleischmann, R. (Univ., Erlangen, Ger.). Phys. Lett.; 30B: 465-6(24 Nov 1969).

The analyzing power A of the ^{90}Zr(p,p$_1$)^{90}Zr(1.75 MeV; 0$^+$) reaction was measured near the $d_{\frac{5}{2}}$ isobaric analog resonance at E_p = 8.5 MeV. An estimate of the non-resonant direct scattering amplitude is obtained from the magnitude of A. (auth)

13364 LOW-ENERGY 2$^-$ LEVEL IN ^{110}Ag. Rivier, Janine; Gizon, Andree (Institut des Sciences Nucleaires, Grenoble, France). J. Phys. (Paris); 30: 615-17(Aug-Sep 1969). (In French).

The electron spectrum in the range 0.9 to 10 keV from the decay of ^{110m}Ag was studied. A group of M internal conversion of a (3.7 ± 0.2) keV transition with E1 character is obtained, so, the first excited state 2$^-$ of ^{110}Ag nucleus is confirmed. (auth)

13365 OCTUPOLE VIBRATIONS OF EVEN NUCLEI IN THE TRANSURANIC REGION. Blocki, J.; Kurcewicz, W. (Inst. of Nuclear Research, Swierk, Poland). Phys. Lett.; 30B: 458-9 (24 Nov 1969).

The energies of the first excited odd parity vibrational levels of even nuclei from the transuranic region, were calculated in the microscopic approach. The results obtained are in good agreement with the experimental data. (auth)

13366 MEASUREMENTS OF THE NUCLEAR SPIN OF ^{204}Tl, THE HYPERFINE STRUCTURE SPLITTING OF ^{66}Cu, AND THE NUCLEAR MAGNETIC MOMENTS OF ^{108}Ag (2.3 min) AND ^{110}Ag (24s). Cussens, C. J.; Rochester, G. K.; Smith, K. F. (Univ. of Sussex, Brighton, Eng.). J. Phys., A (London); 2: 658-65 (Nov 1969).

By using atomic beam magnetic resonance techniques it was shown that the nuclear spin of ^{206}Tl (half-life 4.2 min) is either zero, or else the nuclear magnetic moment $\mu_I < 10^{-5}$ nuclear magnetons. Measurements on isotopes of copper and silver yielded values for their nuclear spins I and hyperfine interaction constants A, from which their nuclear magnetic moments were deduced using the Fermi–Segrè relation. No diamagnetic correction was applied. (auth) (UK)

13367 MICROSCOPIC ANALYSIS OF THE ^{3}He INELASTIC SCATTERING FROM ^{90}Zr. Park, J. Y. (North Carolina State Univ., Raleigh). New Phys. (S. Korea), Suppl.; 9: No. 1, 43-8 (Nov 1969).

Inelastic scattering of 43.7-MeV ^{3}He particles from ^{90}Zr was investigated in terms of the microscopic model using the shell-model wave functions for the bound state and a phenomenological effective interaction of Yukawa form. Effects of radial cut-off and the non-locality of the bound states on the angular distributions are studied. Calculated differential cross sections are found to be sensitive on the range of the Yukawa interaction. The results are compared with the prediction of the collective model. A Yukawa interaction with a range of 0.9 fm and a strength of about 1253 MeV was found to give a good fit to the L = 2 excitation of the 2.18 MeV 2$^+$ state arising from the $g_{\frac{9}{2}}^2$ proton configuration. This strength is almost identical to that obtained previously in the (t,t') study. (auth)

13368 HALF-LIFE OF ^{198}Au. Costa Paiva, M. M.; Martinho, E. (Laboratorio de Fisica e Engenharia Nucleares, Sacavem, Portugal). Int. J. Appl. Radiat. Isotop.; 21: 40-2(Jan 1970).

The half-life of ^{198}Au was measured, using a γ-ray spectrometer, over 10.6 half-lives, and a value of 2.6962 days was obtained. After consideration of the sources of error a final figure of 2.696 ± 0.004 days is given and compared with the weighted mean of 2.6963 ± 0.0013 days using previous reliable results. (UK)

13369 NUCLEAR DECAY PROPERTIES OF LIGHT EINSTEINIUM ISOTOPES. Ahmad, I.; Sjoblom, R. K.; Barnes, R. F.; Horwitz, E. P.; Fields, P. R. (Argonne National Lab., Ill.). Nucl. Phys.; A140: 141-53(1970).

The light einsteinium isotopes ^{248}Es, ^{249}Es, ^{250}Es, and ^{251}Es were synthesized by irradiating a ^{249}Bk target with ^{3}He and ^{4}He ions. Because of the short half-life of ^{248}Es, it was necessary to characterize this isotope by using the recoil technique, whereas the other isotopes were chemically purified before their properties were determined. The half-lives of the above nuclides were found to be 28 ± 5 min, 1.7 ± 0.1 h, 8.3 ± 0.2 h, and 33 ± 1 h, respectively. A new isomer of ^{250}Es was discovered and its half-life was determined to be 2.1 ± 0.2 h. The energies of the main α groups for ^{248}Es, ^{249}Es and ^{251}Es were observed to be 6.87 ± 0.01, 6.770 ± 0.005, and 6.488 ± 0.005 MeV, respectively. The α/K x-ray ratio for ^{249}Es was found to be 0.007 ± 0.001 and the value for ^{251}Es was 0.008 ± 0.002. Several gamma rays associated with the electron-capture decay of the einsteinium isotopes were observed. On the basis of the present investigation the ground states of ^{249}Es and ^{251}Es have been assigned to the Nilsson states $\frac{7}{2}^+$(633↑) and $\frac{3}{2}^-$ (521↑), respectively. (auth)

13370 FISSION PRODUCED BY K$^-$ MESONS OF 1.5 GeV/c ON Ag AND Br NUCLEI. Juric, M.; Popov, S.; Todorovic, Z. (Inst. of Physics, Belgrade). Nucl. Phys.; A140: 154-60(1970).

The process of fission by disintegration of Ag and Br nuclei in photonuclear emulsion irradiated by K$^-$ mesons of 1.5 GeV/c is investigated. Special cases of fission with hypernucleus as a fragment are also studied. (auth)

13371 COULOMB EXCITATION AND REORIENTATION OF THE OCTUPOLE STATE IN ^{208}Pb. Barnett, A. R.; Phillips, W. R. (Univ. of Minnesota, Minneapolis). Phys. Rev.; 186: 1205-19(20 Oct 1969).

The static quadrupole moment (Q) of the 2.614-MeV 3$^-$ level in ^{208}Pb was measured by observing the angular distribution of inelastically scattered ^{4}He and ^{16}O ions following E3 Coulomb excitation. The reduced matrix element for the E3 transition from the ground state to the 3$^-$ state, B(E3) ↑, was also obtained. Distributions were taken over the range 80°–170°, using a multiple solid-state–detector array, at α-particle energies of 19, 18, and 17.5 MeV, and at an oxygen energy of 69.1 MeV. Differential inelastic cross sections were in the range 10–40 μb/sr for α's and 200–300 μb/sr for oxygen. The 19-MeV data showed strong interference between the Coulomb-excitation amplitude and an amplitude resulting from direct nuclear excitation. The remaining three sets of data showed no such interference and were analyzed simultaneously using the symmetrized semiclassical Coulomb-excitation theory of Alder et al.: The fitted parameters B(E3) ↑ and Q are correlated, with best-fit values of B(E3) ↑ = 0.58 ± 0.04 e^2 b^3 and Q = −1.3 ± 0.6 b. The α data are not very sensitive to Q and yet are essential to the result, for the analysis of the α and oxygen data together limits the acceptable parameter range much more than if the oxygen data alone are used. (auth)

13372 TWO-PHONON TRIPLET IN ^{136}Ba AND DECAY OF ^{136}La. Meyer, R. A.; Griffioen, R. D. (Univ. of California, Livermore). Phys. Rev.; 186: 1220-6(20 Oct 1969).

Over twenty γ rays were detected in the decay of 9.9-min ^{136}La. A high-resolution 30-cc Ge(Li) detector was used in conjunction with a pileup-rejector network which allowed the collection of undistorted data with a 40% dead time. Analysis of these data indicate levels at (J^π): 818.51 (2$^+$), 1551.1 (2$^+$), 1579.01 (0$^+$), 2080.6 (2$^+$), 2128.92 (1$^+$), 2141.50 (0$^+$), 2284.5 (0$^+$, 1, 2), 2315.42 (0$^+$), (2322) (?), 2485.4 (1$^+$, 2$^+$), 2531.7 (3$^-$), (2609.9) (?), (2670.5) (?),

and 2773 keV. The results are compared to those of reaction spectroscopy. The most notable difference between the more complete data and analysis and those of previous decay-scheme studies is evidence that the second 2^+ state is at 1551.1 keV, and that the state at 1579.01 keV is assigned to be the 0^+ member of the two-phonon triplet. (auth)

13373 ANOMALOUS γ-BAND INTRABAND TRANSITION RATES IN ^{166}Er. Sunyar, A. W. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev.; 186: 1227-9(20 Oct 1969).

The $7+ \rightarrow 6+$, $6+ \rightarrow 5+$, and $5+ \rightarrow 4+$ intraband transitions within the γ vibrational band of ^{166}Er were observed. The intensities of these transitions were measured relative to the E2 crossover transitions which originate from the same states. The $\Delta I = -1$ "stopover" transitions have intensities which exceed the Alaga-rule predictions for pure E2 $\Delta I = -1$ transitions. The excess intensity is indicative of an M1 admixture into these transitions, in contrast to a vanishing M1 rate which would be anticipated if rotational states correspond to the rotation of a uniform nuclear fluid. The square of the M1 matrix element, which is deduced from these data, increases with the spin of the initial state approximately as $I^2(I + 1)^2$. (auth)

13374 NUCLEAR QUADRUPOLE MOMENT OF ^{237}Np. Dunlap, B. D.; Kalvius, G. M. (Argonne National Lab., Ill.). Phys. Rev.; 186: 1296(20 Oct 1969).

Measurements obtained from Moessbauer-effect, optical-spectroscopy, and Coulomb-excitation data are combined to provide a value of + (4.1 ± 0.7) b for the nuclear quadrupole moment of ^{237}Np. (auth)

13375 NEUTRON DECAY OF ISOBARIC ANALOG RESONANCES IN ^{90}Zr. Lieb, K. P.; Hausmann, T. (Univ. of Texas, Austin). Phys. Rev.; 186: 1229-41(20 Oct 1969).

Excitation functions and angular distributions of the γ radiation from ^{89}Zr following the reaction ^{89}Y(p, n) were measured with a 56-cm^3 Ge(Li) detector in the range from 5.4- to 7.8-MeV bombarding energy. At 6.00-, 6.16-, 7.28-, and 7.45-MeV bombarding energy, resonances in several neutron channels were observed which were attributed to isobaric analog states in the compound system ^{90}Zr. From an analysis of the 6.16-MeV 1^- resonance in terms of Robson's theory, the level shift $\Delta = 86$ keV was obtained which was compared with an estimate derived from the spreading width of this resonance. New states in ^{90}Zr were identified at 1834-, 2081-, 2130-, 2220-, 2298-, 2389-, 2570-, and 2610-keV excitation energy. From a Hauser–Feshbach analysis of the γ-ray excitation functions and angular distributions, the spins of a number of these states and mixing ratios of γ-ray transitions were found. Evidence is given for a weak coupling multiplet of a $g_{9/2}$ neutron hole coupled to the 2.18-MeV 2^+ state in ^{90}Zr. (auth)

13376 REORIENTATION-EFFECT MEASUREMENTS ON ^{114}Cd. Saladin, J. X.; Glenn, J. E.; Pryor, R. J. (Univ. of Pittsburgh). Phys. Rev.; 186: 1241-9(20 Oct 1969).

Using a 42-MeV ^{16}O beam, the angular dependence of the excitation probability for exciting the first 2^+ state in ^{114}Cd has been determined. The energy dependence of the same quantity was determined by means of an α beam. From these data, the quadrupole moment Q_{2^+} of the first 2^+ state was determined, as well as the reduced transition probability B(E2, $0 \rightarrow 2^+$). The two sets of data are consistent with each other and with particle-γ-coincidence experiments of several other groups. A detailed account of the experimental techniques and the method of evaluation is given. (auth)

13377 LIFETIME OF THE 11-keV LEVEL IN ^{134}Cs. Lynch, F. J.; Glendenin, L. E. (Argonne National Lab., Ill.). Phys. Rev.; 186: 1250-2(20 Oct 1969).

The mean life of the 11-keV level following the decay of ^{134m}Cs was measured by a delayed-coincidence technique and found to be 69 ± 1 nsec. An indirect measurement of the total-internal-conversion coefficient for this transition ($\alpha = 105$) agrees closely with the theoretical value for a pure M1 transition. This implies that the mean life for radiative decay is $\tau_0 = 7314$ nsec. This is about 1.8 times the radiative mean life calculated with the odd-group model with the aid of the magnetic moments of neighboring nuclei. (auth)

13378 g-FACTOR MEASUREMENTS IN ^{192}Os AND ^{192}Pt. Levanoni, M. (California Inst. of Tech., Pasadena). Contract AT(04-3)-63. Phys. Rev.; 186: 1253-4(20 Oct 1969).

The g factors of the first 2^+ state in ^{192}Os and the first and second 2^+ states in ^{192}Pt were measured by γ-γ perturbed angular correlation using Ge(Li) and NaI(Tl) spectrometers. The results are $g_{2^+}(^{192}\text{Os}) = 0.28 \pm 0.04$, $g_{2^+}(^{192}\text{Pt}) = 0.28 \pm 0.03$, and $g_{2'^+}(^{192}\text{Pt}) = -0.13 \pm 0.07$. While the first and second quoted results agree well with calculation based on collective models, the last result gives evidence for a predominantly noncollective excitation. (auth)

13379 PHOTONEUTRON CROSS SECTIONS FOR ^{116}Sn, ^{117}Sn, ^{118}Sn, ^{119}Sn, ^{120}Sn, ^{124}Sn, AND INDIUM. Fultz, S. C.; Berman, B. L.; Caldwell, J. T.; Bramblett, R. L.; Kelly, M. A. (Univ. of California, Livermore). Phys. Rev.; 186: 1255-70(20 Oct 1969).

Monochromatic photons obtained from the annihilation in flight of fast positrons were used to measure photoneutron cross sections for a number of tin isotopes and indium. Total cross sections for ^{116}Sn, ^{117}Sn, ^{118}Sn, ^{119}Sn, ^{120}Sn, ^{124}Sn, and In have peak values of 266, 254, 255, 253, 280, 283, and 266 mb at energies of 15.67, 15.66, 15.60, 15.54, 15.40, 15.18, and 15.63 MeV, respectively. The respective integrated cross sections were found to be 1.67, 1.89, 1.85, 2.00, 2.07, 2.01, and 1.88 MeV b; while the respective (γ, 2n) integrated cross sections were 0.414, 0.475, 0.531, 0.598, 0.673, 0.670, and 0.509 MeV b. Single-nucleon effects on the giant resonance were examined, and shell effects were determined. Other nuclear quantities determined include nuclear level densities, pairing energies, and integrated moments. (auth)

13380 LEVEL STRUCTURE OF $^{116\ 118\ 120\ 122}$Te. Spejewski, E. H.; Hopke, P. K.; Loeser, F. W. Jr. (Princeton Univ., N. J.). Phys. Rev.; 186: 1270-9(20 Oct 1969).

The decays of ^{116,118,120,122}I were studied by use of isotopically separated sources produced by proton spallation of lanthanum. Ge(Li) γ-ray singles spectra and Ge(Li)–Ge(Li) coincidence spectra were obtained and used in constructing level schemes for the corresponding Te daughters. (auth)

13381 MAGNETIC DIPOLE AND ELECTRIC QUADRUPOLE MOMENTS OF THE FIRST 2^+ STATE OF ^{154}Sm. Wheeler, R. M.; Atzmony, U.; Walker, J. C. (Johns Hopkins Univ., Baltimore). Phys. Rev.; 186: 1280-4(20 Oct 1969).

The hyperfine interactions of the first excited 2^+ state of ^{154}Sm were measured in $SmCl_3 \cdot 6H_2O$ and SmIG at 4.2°K, using the Moessbauer effect following Coulomb excitation. The results in $SmCl_3 \cdot 6H_2O$ were used to determine the magnetic dipole and electric quadrupole moments $\mu^{154} = (0.778 \pm 0.036)\mu_N$ and $Q^{154}(1 - R) = -1.33 \pm 0.46$ b, respectively. μ^{154} was used to determine $H_{eff} = 3.04 \pm 0.12$ MG in SmIG at 4.2°K. This value for H_{eff}(SmIG) agrees with the value used by Atzmony et al. to measure $g_{R^{152}}$ in SmIG; thus their value for $g_{R^{152}}$ is confirmed. An improved technique for using the Moessbauer effect following Coulomb excitation is reported. (auth)

13382 STUDY OF THE ISOBARS ^{113m}Cd AND ^{113m}In. Der Mateosian, E.; Goldhaber, M. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev.; 186: 1285-8(20 Oct 1969).

The decay schemes of ^{113m}Cd and ^{113m}In were studied. An isomeric transition from ^{113m}Cd to the ground state, previously reported by the authors, was further investigated. An upper limit was placed on the probability for K capture in ^{113m}In (log ft > 6). The conclusion is drawn that ^{113}Cd is the heavier member of the ^{113}Cd–^{113}In isobaric pair, with an available β-decay energy of 316 keV. (auth)

13383 HIGH-ENERGY GAMMA RADIATION ACCOMPANYING THE DECAY OF ^{228}Ac. Ythier, Christian; Dalmasso, Josette; Ardisson, Gerard; Maria, Henriette; Forest, Hugues (Faculte des Sciences, Nice). Compt. Rend., Ser. B; 269: 785-8 (20 Oct 1969). (In French).

Gamma radiation from ^{228}Ac was measured with a pair spectrometer using a germanium detector. More than 27 gammas were observed above 1180 keV; their energies and relative intensities could be determined. (tr-auth)

13384 CROSS SECTION OF ^{249}Bk FISSION BY NEUTRONS. Vorotnikov, P. E.; Dubrovina, S. M.; Otroshchenko, G. A.; Chistyakov, L. V.; Shigin, V. A.; Shubko, V. M. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 10: 726-9(Oct 1969). (In Russian).

The cross section for ^{249}Bk fission is measured in the neutron energy region from 0.2 up to 1.7 MeV and at the energy 5.0 MeV. The cross section is of the threshold type. The fission threshold is 1.0 MeV. The fission cross section on the plateau is 1.3 ± 0.2 b. The effect of the magic number on the ^{249}Bk fissiability is discussed. The period of spontaneous ^{249}Bk fission was found to be $(1.65 \pm 0.17) \times 10^9$ years. (auth)

13385 TERNARY FISSION OF ^{235}U BY SLOW NEUTRONS. Adamov, V. M.; Drapchinskii, L. V.; Kovalenko, S. S.; Petrzhak, K. A.; Tyutyugin, I. I. Yadern. Fiz.; 10: 721-5(Oct 1969). (In Russian).

Kinetic energies of pair fragments and long-range α particles in the fission of ^{235}U by thermal neutrons were studied by surface-barrier detectors. The dependence of E_c on E_α is measured. This was a straight line with the slope $\Delta E_c/\Delta E_\alpha = 0.34$. The α-particle spectra for different values of E_c were measured. The spectra become softer with increase of kinetic energy of the fragments. The

mean energy of α particles decreases from 16.1 down to 14.5 MeV. The dependence of the mean energy of the light and heavy groups of fragments on E_α is obtained. (auth)

13386 KINETIC ENERGY OF FRAGMENTS OF SYMMETRIC FISSION OF ^{235}U NUCLEI BY SLOW NEUTRONS. Arifov, U. A.; Bochagov, B. A.; Ivanov, V. B.; Kovalev, R. L.; Radzhabov, P. S. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz.; 10: 713-20(Oct 1969). (In Russian).

Kinetic energy E_c of the pair fragments of ^{235}U fission by slow neutrons in the region of mass ratios R close to unity and angular distribution of fragments are measured by a double emission ionization chamber with electric collimator. The most probable value of E_c was found to be 156 MeV. It is shown that the underestimated value E_c = 134 to 150 MeV and the increase of σ in the region R < 1.3 observed by other authors are due to methodic effects. It is established that E_c varies slightly with the excitation energy E^* in the region 25 MeV $\gtrsim E^* \gtrsim$ 6 MeV. Within the values of E^* the most probable kinetic energy at R = 1.24 varies stronger than E_c. (auth)

13387 ON MECHANISM OF THE (n,2n) REACTION. Prokopets, G. A.; Strizhak, V. I. (Kiev State Univ.). Yadern. Fiz.; 10: 699-704(Oct 1969). (In Russian).

Angular correlations of neutrons from the (n,2n) reactions on Pb, Bi, I, and Be at the incident neutron energy $E_n \sim 14$ MeV are presented. Relation is deduced between the correlated part of the emission (30%) on Bi and Pb with the simultaneous emission of both neutrons in the partial-equilibrium or in the direct process. An analogous possibility is assumed for Be. (auth)

13388 L_I: L_{II}: L_{III} RATIOS FOR M4-TRANSITIONS IN ^{123}Te, ^{125}Te, ^{127}Te, AND ^{129}Te NUCLEI. Kalinauskas, R. A.; Makaryunas, K. V.; Davidonis, R. I. (Inst. of Physics and Mathematics, Vilnyus, USSR). Yadern. Fiz.; 10: 690-3(Oct 1969). (In Russian).

L_I: L_{II}: L_{III} ratios for M4 transitions in ^{123}Te, ^{125}Te, ^{127}Te, and ^{129}Te were measured using the prismatic beta spectrometer with momentum resolution $\Delta p/p$ = 0.04 to 0.09%. The experimental ratios are compared with the theoretical results by Sliv and Band and Rose. (auth)

13389 RADIATION OF EVEN-ODD NUCLEI NEAR THE MAGIC NUMBER N = 82 AFTER THERMAL NEUTRON CAPTURE Groshev, L. V.; Dvoretskii, V. N.; Demidov, A. M.; Alvash, M. S. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 10: 681-9(Oct 1969). (In Russian).

Gamma-ray spectra from even-odd nuclei $^{135, 137, 139}$Ba and $^{139, 141, 143}$Ce were measured by means of a one-crystal spectrometer on the external thermal beam from the IRT-M Reactor of the Institute of Atomic Energy. The spectra in combination with the γ-ray spectra of neodymium odd nuclei enable one to observe some regularities in the radiation of even-odd nuclei with the neutron numbers N = 79, 81, 83, and 85, that give some evidence of the direct thermal neutron capture by even-even nuclei near the magic number N = 82. (auth)

13390 NATURE OF EXCITED STATES OF THE NUCLEUS ^{131}Cs. Khodzhaev, M. M.; Begzhanov, R. B.; Salikhbaev, K. T. (Inst. of Nuclear Physics, Tashkent). Yadern. Fiz.; 10: 673-80(Oct 1969). (In Russian).

Lifetimes of the excited levels of the nucleus ^{131}Cs with energies of 124, 133, 216, and 373 keV are measured by $\gamma\gamma$ and KX$\gamma\gamma$-delayed coincidence methods. The following half-lives are obtained: 124 keV, $(3.79 \pm 0.08) \times 10^{-9}$ sec; 133 keV, $(9.13 \pm 0.20) \times 10^{-9}$ sec; 216 keV, $\leq 0.25 \times 10^{-9}$ sec; 373 keV, $\leq 0.25 \times 10^{-9}$ sec. Angular $\gamma\gamma$ correlations for the cascades 496-124, 924-124, 486-133, 480-216, 832-216, 247-373, and 674-373 keV in the nucleus ^{131}Cs are also investigated. The result is the following quantum numbers of the levels: 124 keV, $3/2^+$; 133 keV, $5/2^+$; 216 216 keV, $3/2^+$; 373 keV, $5/2^+$; 620 keV, $1/2^+$ (or $3/2^+$ or $5/2^+$); 1048 keV, $3/2^+$. The results are discussed and compared with the predictions of the Davydov model of nonaxial odd nuclei. (auth)

13391 ELASTIC ELECTRON SCATTERING BY ^{208}Pb AND NEW INFORMATION ABOUT THE NUCLEAR CHARGE DISTRIBUTION. Heisenberg, J. (Stanford Univ., Calif.); Hofstadter, R.; McCarthy, J. S.; Sick, I.; Clark, B. C.; Herman, R.; Ravenhall, D. G. Phys. Rev. Lett.; 23: 1402-5(15 Dec 1969).

An analysis of electron-scattering experiments gives a nuclear charge distribution which (A) has a central depression of about 7%, (B) falls off at the nuclear edge faster than the customarily used Fermi distributions, (C) has no detectable energy dependence, and (D) appears to have an undulation of rather small magnitude. (auth)

13392 DECAY SCHEME OF ^{125}Xe. Ludziejewski, J. (Inst. of Nuclear Research, Swierk, Poland); Kownacki, J.; Klamra, W.; Chwaszczewska, J.; Przyborski, W.; Pomorski, J. Acta Phys. Pol.; 36: 939-50(Dec 1969).

A study of the decay scheme of ^{125}Xe → ^{125}I was carried out using germanium and silicon detectors as well as NaI(Tl) and anthracene crystals. Samples of ^{125}Xe were prepared by irradiating natural Xe in a reactor. Some of the measurements were also made with the use of mass-separated ^{125}Xe sources. Singles and coincidence γ spectra were measured. The total decay energy of ^{125}Xe → ^{125}I was found to be 1735 ± 40 keV from the $\beta^+ - \gamma 2.3.4$ and $\beta^- -$ K243.4 coincidence spectra. The relative intensities of gamma rays and the left values of β transitions were determined. Results suggest spin $1/2^+$ for the ground state of ^{125}Xe. The level scheme of ^{125}I is proposed. (auth)

Nuclear Theory

Refer also to abstracts 13235 and 13365.

13393 CONSIDERATIONS ABOUT A UNIFIED NUCLEAR REACTION THEORY. Wildermuth, K. (Univ., Tuebingen, Ger.). Z. Phys.; 229: 365-71(1969). (In German).

It is briefly reviewed how one can obtain in the frame of the Rayleigh-Schroedinger variational principle a unified structure and reaction theory which includes any kind of bombarding particles and reaction fragments. Then methods are discussed which allow one to simplify the practical reaction calculations. Special emphasis is given to the question how in a natural way one can connect shell-model and cluster calculations. Finally it is briefly mentioned how one can apply similar considerations to the atomic- and molecular-reactions. (auth)

13394 A CONTRIBUTION TO THE PROBLEM OF EFFECTIVE PARTICLE-HOLE INTERACTIONS. Werner, E. (Technische Univ., Hanover). Z. Phys.; 229: 403-9(1969).

Various effects arising in nuclear-structure calculations and leading all to a renormalization of the nucleon-nucleon interaction are reviewed. A new treatment is proposed for the renormalization due to mixing of the particle-hole subspace and the n particle-n hole (n = 2, 3, 4 etc.) subspaces. (auth)

13395 SECOND RANDOM PHASE APPROXIMATION VIA THE GENERATOR COORDINATE METHOD. Mann, A.; Nissimov, H.; Unna, I. (Hebrew Univ., Jerusalem). Nucl. Phys.; A139: 673-85(1969).

A second RPA is derived by an extension of the generator coordinate method employed by Jancovici and Schiff for a derivation of the RPA. The connection between the present second RPA and the one derived by Sawicki and by da Providencia is discussed. An approximate form of it is applied to the solvable model of Lipkin, Meshkov and Glick, with good results. Possible applications to the study of collective phenomena in nuclei are indicated. (auth)

13396 SECOND ORDER EFFECTS IN THE COULOMB EXCITATION OF DOUBLY EVEN NUCLEI. Seaman, G. G. (Rutgers-The State Univ., New Brunswick, N. J. Kansas State Univ., Manhattan); de Boer, Jorrit. Nucl. Phys.; A139: 692-6(1969).

A recent compilation of graphs containing orbital integrals for the calculation of second-order processes in the Coulomb excitation of doubly even nuclei was used to estimate the way in which reorientation experiments depend on interference terms via higher 2^+ states. A possible way to measure the interference term by gamma angular distribution experiments is considered. (auth)

13397 STRIPPING REACTIONS LEADING TO DECAYING STATES. Bang, J.; Zimanyi, J. (Univ. of Copenhagen). Nucl. Phys.; A139: 534-44(1969).

Cross sections for stripping reactions leading to states in the continuum, described as single-particle resonances, are given, using Gamow's decaying state function as form factors in DWBA calculations. The results are compared to measured differential cross sections and estimates of spectroscopic factors for the cases Zr(d,n) and Pb(d,p). (auth)

13398 COMPARISON BETWEEN THE EVAPORATION AND THE BREAK-UP MODELS OF NUCLEAR DE-EXCITATION. Epherre, Marcelle (CNRS, Orsay, France); Gradsztajn, Eli; Klapisch, Robert; Reeves, Hubert. Nucl. Phys.; A139: 545-53 (1969).

A discussion of the physical implications of the break-up calculations of high-energy nuclear reactions is presented. The relative merits of the break-up and evaporation models are assessed. (auth)

13399 SINGLE-PARTICLE LIMIT FOR PARTIAL WIDTHS. Dover, Carl B. (Univ. of Copenhagen); Mahaux, C.; Weidenmueller, Hans A. Nucl. Phys.; A139: 593-604(1969).

According to one of the Wigner-Teichmann sum rules of R-matrix theory, the average reduced partial width cannot exceed the single-particle limit. The implications of this rule for the

observable widths are discussed. The existence of a similar restriction within the framework of the shell-model approach to nuclear reactions is investigated. Simple physical arguments are presented for the existence of such a limit for the partial widths of each individual resonance. (auth)

13400 TWO-NUCLEON TRANSFER IN THE 1p SHELL. Cohen, S.; Kurath, D. (Argonne National Lab., Ill.). Nucl. Phys.; A141: 145-57(1970).

Two-nucleon c.f.p. are given for the 1p shell, based on an earlier effective-interaction calculation. Magnitudes are also given which indicate the strength expected for two-nucleon transfer reactions. (auth)

13401 MODEL CALCULATIONS WITH PAIRING FORCES. Bang, J. (Univ. of Copenhagen); Krumlinde, J. Nucl. Phys.; A141: 18-32(1970).

Energies and occupation numbers for a symmetric 32-level model with pairing interaction are investigated. Exact calculations are compared with the approximations BCS and BCS + RPA + projection. The numbers calculated with the last method are shown to be in good agreement with the exact values for the present model. (auth)

13402 ANGULAR DISTRIBUTION OF STRETCHED E2 TRANSITIONS FOR GAUSSIAN SUBSTATE POPULATION OF SIDE FEEDING IN (particle,xnγ) REACTIONS. Draper, James E.; Lieder, Rainer M. (Univ. of California, Davis). Nucl. Phys.; A141: 211-24(1970).

In (particle,xnγ) reactions the population of magnetic substates of a given level of spin J in the ground state quasirotational band resulting from the preceding neutrons and gamma from outside the band (i.e., side feeding) can be described by a mixture of Gaussians of various widths. The resulting angular distribution of the stretched E2 (denoted $\overline{E2}$) gammas with respect to the direction of the particle beam is analyzed here. It is not approximated that an $\overline{E2}$ transition from a Gaussian distribution of substates of level J produces a Gaussian distribution for the final level J − 2. The (A_2,A_4) results are discussed for a state populated by previous $\overline{E2}$ transitions plus a single Gaussian side feeding. The results are extended to include side feeding producing substate populations of any mixture of Gaussians. A method of exact solution is given for cases where the experimental data are sufficiently accurate. The region of the (A_2,A_4) space which can result from any mixture of Gaussian side feedings is derived. The results of various assumed substate populations of side feeding are compared to experiments by Newton et al. on $^{182}W(\alpha,2n)^{184}Os$, $^{165}Ho(^{11}B,4n)^{172}Hf$ and $^{159}Tb(^{14}N,5n)^{168}Hf$. The comparison is quite satisfactory for single Gaussian side feeding of width $\sigma = 2.8$ for each level of spin J. The qualitative differences in the angular distributions for these experimental cases are caused by different experimental intensities of side feeding. For $^{74}Ge(\alpha,2n)^{76}Se$ a width $\sigma = 1.6 + 0.1$ J gives good agreement with our experimental angular distributions of the transitions $10 \rightarrow 8$, $8 \rightarrow 6$, $6 \rightarrow 4$, $4 \rightarrow 2$ and $2 \rightarrow 0$. The angular distribution is also derived for a case where the population of substates increases with M. (auth)

13403 SU(3) TECHNIQUES FOR SHELL MODEL STUDIES AND THE SPECTRA OF A = 25 NUCLEI. Vergados, John Demetrius. Ann Arbor, Mich.; Univ. of Michigan (1968). 182p.

Thesis.

The formalism was developed to apply a generalized irreducible tensor operator technique for shell model calculations in 2s-1d shell nuclei using the SU(3) basis. Mathematically this involves the study of the group chain SU(6) ⊃ SU(3) ⊃ R(3) ⊃ R(2). For the SU(3) ⊃ R(3) part the extra label needed to classify the states is provided in a systematic way, which gives rise to an orthonormal basis tied closely to the physically meaningful basis introduced by Elliott. SU(6) ⊃ SU(3) and SU(3) ⊃ R(3) Wigner coefficients as well as SU(6) and SU(3) Racah coefficients are discussed and calculated. For the SU(3) ⊃ R(3) part the calculations cover most of the cases of physical interest in the 2s-1d shell. 1-body and 2-body operators are expanded in terms of SU(6) × SU(4) irreducible tensor operators. By applying a generalized Wigner–Eckart theorem in this scheme the many-particle matrix elements of these operators take a very simple form so that most of the summations are easily performed and the result is expressed in terms of SU(6) and SU(4) Wigner and Racah coefficients. An initial calculation using the above formalism was performed for A = 25 nuclei. The basis was truncated to include only the first and second highest possible spacial symmetries. Only 2 SU(3) representations were included in the first and 1 SU(3) representation in the second. Because of this severe truncation of the basis the agreement between experimental and calculated energy levels is not very good. (Diss. Abstr.)

13404 THE INFLUENCE OF NUCLEAR EXCITATIONS ON THE MUONIC X-RAY SPECTRUM OF HEAVY SPHERICAL NUCLEI. Ruppert, F.-W.; Tuan, S. T.; Chen, Y.-K.; Greiner, W. (Univ., Frankfurt am Main). Nucl. Phys.; A139: 563-92(1969).

The dependence of the x-ray spectrum of the muonic atoms of heavy spherical nuclei on the nuclear properties is discussed for doubly even and odd-mass isotopes. In the doubly even case the nucleus is described as a system of (2L + 1)-dimensional oscillators, L ranging from 2 over all reasonable multipolarities. In the odd-mass case the nucleus is described by the model of core excitation, where surface vibrations and particle motions are taken into account. The results are compared with the predictions for rotational nuclei. As expected, typical differences occur and thus muonic x-rays might be used as a tool for discriminating between various nuclear models, especially in the transition region from deformed to spherical nuclei. (auth)

13405 CLASSIFICATION OF THREE-NUCLEON STATES. Doherty, William Ross. Eugene, Oreg.; Univ. of Oregon (1968). 152p.

Thesis.

The first step in a study of the three nucleon system is a complete classification of the states of the system. The method of classification that is used is a group theoretic one. The group of the Hamiltonian is the direct-product group of the translation, rotation-reflection, isospin rotation groups and the symmetric group of degree three. The functions of the coordinates of the three particles are classified according to the row of the irreducible representation of the group to which they belong. The construction of the basis vectors as eigen functions of ten commuting operators is outlined. The sixteen basis vectors which span the space containing the ground state function are explicitly constructed. These functions are employed in the reduction of the matrix elements of operators which are contained in the Hamiltonian. These include the gradient operator, the Laplacian, and the two-particle spin-orbit and tensor interactions. For the differential operators it was necessary to generalize the reduction method of Wigner and Hirschfelder (1935) to treat cases when the standard position depends upon the size and shape of the configuration of particles. The matrix elements of a phenomenological nuclear Hamiltonian among the basic vectors for the ground state are reduced explicitly. (Disser. Abstr. Int., B)

13406 ON A NEW TYPE OF FISSION-ISOMERIC STATE. Nilsson, S. G.; Ohlen, G.; Gustafson, C.; Moeller, P. (Lund Inst. of Tech., Sweden). Phys. Lett.; 30B: 437-40(24 Nov 1969).

A study of the relevant single-particle diagram reveals the presence of a unique neutron orbital $[505\,11/2]$ which for $N \approx 144$-150 passes through the Fermi surface for the distortion shapes characteristic of the fission-shape-isomeric state. This orbital gives rise to a specialization energy in excess of 4 MeV for the second barrier peak. This energy increment is in turn expected to be associated with an increase in the half-life of the "normal" fission-shape-isomer by a factor of about 10^{15}. Recent experimental findings of a 0.3 year isomer in ^{241}Pu is explained in terms of the specialization energy connected with this orbital. (auth)

13407 PHASE SHIFTS AND MATRIX ELEMENTS OF POTENTIALS. Bollini, C. G. (Univ. Nacional, La Plata); Giambiagi, J. J. Phys. Lett.; 30B: 441-3(24 Nov 1969).

J. P. Elliott et al. have computed particular matrix elements of the potentials, starting from experimentally known phase shifts and using approximate relations. Based on properties of the Jost functions, a formula is proposed here so to improve that approximation. (auth)

13408 SPIN–ORBIT VIBRATIONS IN NUCLEI. Belyaev, S. T.; Rumyantsev, B. A. (Inst. of Nuclear Physics, Novosibirsk, USSR). Phys. Lett.; 30B: 444-5(24 Nov 1969).

A new mechanism of monopole vibrations of nuclei, generated by a two-particle spin-orbit force is suggested. The 0^+ states of this character are estimated to lie below the two-quasiparticle threshold and have strong E0 transitions into the ground state. They can be rather strongly excited in two-particle transfer reactions. (auth)

13409 BREAKUP CORRECTIONS TO THE DEUTERON OPTICAL POTENTIAL. Bencze, Gy.; Szentpetery, I. (Central Research Inst. for Physics, Budapest). Phys. Lett.; 30B: 446-8 (24 Nov 1969).

In the framework of a three-body model breakup corrections to the deuteron optical potential are evaluated. By a semiphenomenological treatment of the corrections good agreement with experimental data is obtained for a range of nuclei. (auth)

13410 ACCURACY OF A SEPARABLE APPROXIMATION. Harms, E.; Levinger, J. S. (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Lett.; 30B: 449-50(24 Nov 1969).

It is shown that a separable approximation can reproduce the two-body Malfliet-Tjon T-matrix quite accurately. The results agree with their three-body binding energy to an accuracy of 2%. (auth)

13411 DROPLET MODEL ISOTOPE SHIFTS AND THE NEUTRON SKIN. Myers, W. D. (Niels Bohr Inst., Copenhagen. Univ. of California, Berkeley). Phys. Lett.; 30B: 451-4(24 Nov 1969).

The isotope and isotone shifts in the nuclear charge radius and the thickness of the neutron skin are calculated for nuclei along beta stability by means of the droplet model. (auth)

13412 INTEGRO-DIFFERENTIAL EQUATIONS FOR LIGHT NUCLEI. Omojola, D. A. F. (Univ. of Lagos, Nigeria). J. Phys., A (London); 2: 666-71(Nov 1969).

Two methods of deriving the integro-differential equations for light nuclei are given. The resonating-group method of J. A. Wheeler (1937) is employed to construct the wave function and from the Schroedinger equation a set of simultaneous integro-differential equations is derived. (auth) (UK)

13413 ISOBARIC ANALOGUE STATES IN NUCLEI. Murthy, Meera (Indian Inst. of Tech., Kanpur). J. Phys., A (London); 2: 672-6(Nov 1969).

The masses within an isobaric multiplet are related by the general model-independent mass formula: $M(A, T, T_z) = a(A, T) + b(A, T)T_z + c(A, T)T_z^2$. The values of the coefficients b(A, T) and c(A, T) were extracted from experimental data as a function of mass number for several triplets ranging from A = 6 to A = 32. Theoretical calculations are made for these coefficients on the basis of Coulomb interaction alone after accounting for the neutron–proton mass difference, and the residual shifts are attributed to charge-dependent effects in the nuclear forces. A phenomenological effective charge-dependent potential is introduced and its parameters are determined by a least-square analysis. (auth) (UK)

13414 DESCRIPTION OF COLLECTIVE 0^+ STATES IN THE TAMM–DANCOFF APPROXIMATION. Kleber, Manfred (Technische Hochschule, Munich). Z. Phys.; 231: 421-33(1970).

The Tamm–Dancoff approximation is applied to the correlated FBCS ground state. This procedure proves very successful for medium and heavy nuclei, both superconducting and nonsuperconducting. The accuracy of the Tamm–Dancoff approximation is equivalent to fourth-order boson methods. Calculations have been performed for the nickel isotopes, for ^{114}Sn, and for the lead isotopes. The connection with the broken-pair approximation is established. The influence of a nucleus with N–2 nucleons on the spectrum of a nucleus with N particles is exhibited. (auth)

13415 COULOMB DISTORTIONS IN HEAVY-ION REACTIONS. Holm, H.; Scharnweber, D.; Scheid, W.; Greiner, W. (Univ., Frankfurt am Main). Z. Phys.; 231: 450-67(1970).

In heavy-ion scattering the Coulomb potential deviates from the potential of two point charges since vibrations, rotations, and giant resonances are excited in both projectile and target nuclei as a result of their mutual electrostatic forces. In this paper this effect is calculated using a classical model. The adiabatic and the dynamical solutions of the problem are compared and discussed. (auth)

13416 CALCULATION OF D_Λ DIRECTLY FROM Λp SCATTERING CROSS SECTIONS. Bhaduri, R. K.; Law, J. (McMaster Univ., Hamilton, Ont.). Nucl. Phys.; A140: 214-24(1970).

The well-depth D_Λ of a Λ-particle in nuclear matter is calculated directly from the Λp cross-section data, assuming that the ΛN interaction in nuclear matter is the free reaction matrix t^F. With this assumption, the depth is 77 MeV for $k_F = 1.36$ fm^{-1}, out of which about 7 MeV comes from the p-state. A crude estimate of the second-order term is –19 MeV, which reduces D_Λ to about 58 MeV. (auth)

13417 SEQUENTIAL REACTION A + B → C* → D + G* → D + E + F. Goulard, Gisele (Univ. Laval, Quebec). Nucl. Phys.; A140: 225-39(1970). (In French)

A general formula for the differential cross section is obtained in the case of a sequential reaction A + B → C* → D + G* → D + E + F. It is used to explain the particular reaction ^{11}B(p,α)2α. The identity of the three final particles is taken into account. Some numerical results are given for an incident energy of 2 MeV and compared with some known experimental data. The effects of the interference terms are clearly seen. (auth)

13418 CLEBSCH–GORDAN COEFFICIENTS FOR SU(3) ⊃ R_3 IN DIFFERENT BASES. von Baeyer, Hans C. (Coll. of William and Mary, Williamsburg, Va.). Nucl. Phys.; A140: 118-28(1970).

Different bases for representations of SU(3) ⊃ R_3 are compared and related. The metric matrices (overlaps and normalizations) for the general cases are derived. In an earlier paper, a method of invariants for finding Clebsch–Gordan coefficients was outlined. This method is further discussed here for cases with internal multiplicity. An alternate method which was previously used for SU(3) ⊃ SU(2) is proposed and illustrated for the case $(p,q) \times (1,0) \rightarrow (p+1,q)$. (auth)

13419 MATRIX ELEMENTS OF MANY-PARTICLE–MANY-HOLE STATES WITH AN APPLICATION TO ISOSPIN MIXING IN THE MASS-17 SYSTEM. Walker, G. E.; Schlobohm, D. (Stanford Univ., Calif.). Nucl. Phys.; A140: 49-68(1970).

General formulas are given for the evaluation of matrix elements involving m-particle–n-hole states in the occupation number representation. The technique of algebraic computation has been used as a check on the explicit results. As an example, the isospin impurities in the lowest $T = \frac{3}{2}$, $J^\pi = \frac{1}{2}^-$ 2p-1h states of ^{17}F and ^{17}O are predicted using a simple model. Three different contributions to isospin mixing; the particle-particle terms, particle-hole terms, and the off-diagonal matrix elements of the isospin dependent Hartree–Fock energies are discussed. The importance is emphasized of accurate estimates of the Hartree–Fock energies for even qualitative predictions of isospin mixing with the anti-analog state. (auth)

13420 THE NATURE OF THE HARTREE–FOCK ENERGY GAP IN FINITE NUCLEI. Rowe, D. J. (Univ. of Toronto). Nucl. Phys.; A140: 74-80(1970).

The relationship between the HF (Hartree–Fock) energy gap and nuclear deformations is explored by putting the deformed HF equations into a form closely analogous to the BCS gap equations. It is argued that any component of the two-nucleon interaction, responsible for a violation by the HF Hamiltonian of some symmetry invariance of the original Hamiltonian, can be responsible for the energy gap. Illustrative calculations are performed for the prolate and oblate solutions of ^{28}Si. (auth)

13421 IMPROVED METHOD OF CALCULATING FINITE RANGE CORRECTIONS IN TWO-NUCLEON TRANSFER REACTIONS. Chant, N. S.; Mangelson, N. F. (Univ. of Washington, Seattle). Nucl. Phys.; A140: 81-96(1970).

A method is developed for calculating finite range corrections in two-nucleon transfer reactions. Certain approximations of currently used methods are eliminated and no new approximations are introduced. Sample distorted-wave Born approximation calculations are presented. Changes due to the improvement in calculating the finite range corrections are found to be large. (auth)

13422 ORBITING CLUSTERS IN ATOMIC NUCLEI. Pauling, Linus (Stanford Univ., Calif.). Proc. Nat. Acad. Sci. U. S.; 64: 807-9(Nov 1969).

As an alternative to their description as vibrational levels, the low excited states of even-even nuclei can be described as rotational states of a helion, dineutron, diproton, or other cluster about the rest of the nucleus, leading to reasonable values of the average distance between centers of the clusters. Some states involve rotational excitation of two or more helions or other clusters. The nature of the rotating clusters is determined by the relation of the neutron and proton numbers to the magic numbers. (auth)

13423 SOME FEATURES OF THE SINGLE SEPARABLE POTENTIAL WITH ATTRACTION AND REPULSION. Leung, C. C. H.; Park, S. C. (Baylor Univ., Waco, Tex.). Phys. Rev.; 186: 1299(20 Oct 1969).

The separable but nonlocal potential recently introduced by Tabakin has an unfamiliar feature in that the repulsion, introduced to secure a negative phase shift, lends itself to increasing the two-body binding energy. This is illustrated by considering the specific case of the S-wave α-α interaction. (auth)

13424 APPROACH TO THE NUCLEAR MANY-BODY PROBLEM BY A VARIATIONALLY DETERMINED TRANSFORMATION. Mann, A.; Nissimov, H.; Unna, I. (Hebrew Univ., Jerusalem). Phys. Rev.; 186: 1104-5(20 Oct 1969).

Ground-state correlations are introduced via a unitary operator e^{iF}, which is determined by the variational principle. It is surmised that the diagonal part of the transformed Hamiltonian $H' = e^{-iF}He^{iF}$ provides a better starting point for any approximate calculation than the corresponding part of H. The method yields good results for a solvable model. (auth)

13425 METHODS FOR CALCULATING GROUND-STATE CORRELATIONS OF VIBRATIONAL NUCLEI. Johnson, R. E. (McMaster Univ., Hamilton, Ont.); Dreizler, R. M.; Klein, A. Phys. Rev.; 186: 1289-92(20 Oct 1969).

A general method for studying ground-state correlations is de-

scribed. It is shown that the usual random-phase approximation overestimates depletion of the uncorrelated state by a factor of 2, in agreement with a result found by Rowe, using the number-operator method. The correctness of the latter method is then independently verified. A precise division of the ground-state correlations into collective and noncollective parts is shown for a simple model, but it is argued that the division is not valid in general. (auth)

13426 WAVE FUNCTIONS FOR NUCLEAR-STRUCTURE CALCULATIONS. Butler, S. T.; Hewitt, R. G. L.; McKellar, B. H. J.; Nicholls, I. R.; Truelove, J. S. (Univ. of Sydney). Phys. Rev.; 186: 963-5(20 Oct 1969).

A new approximation to the Bethe–Goldstone wave function is proposed, constructed from the two-nucleon potential as follows: The eigenstates of the interacting two-nucleon system with energy eigenvalues less than a certain cutoff energy span a subspace W of the Hilbert space representing the two-nucleon system. The approximation to the Bethe–Goldstone wave function is the projection of the free two-nucleon wave function onto this subspace W. For a suitable choice of cutoff energy, this approximation has the qualitative healing properties expected of the exact Bethe–Goldstone wave function. Moreover, it permits an easy evaluation of reaction matrix elements. The approximation is also applied to the calculation of the reaction matrix elements in the sd shell of the harmonic-oscillator shell model. The nucleon-nucleon potential of Hamada and Johnston was used in the calculation. The resulting energy levels of ^{18}O and ^{18}F are similar to those obtained by Kuo and Brown. (auth)

13427 PLOTNOST' UROVNEI I STRUKTURA ATOMNYKH YADER. (Level Density and Structure of Atomic Nuclei). Malyshev, A. V. Moscow; Atomizdat (1969). 144p.

The current state of the statistical theory of nuclear level densities in the framework of the independent-particle model is examined. With proper allowances for shell and pairing effects, the method is suitable for quantitative estimates of processes proceeding through intermediate states. Model parameters are determined from analyses of the average distances between neutron resonances, average radiation widths, evaporation spectra of inelastically scattered neutrons, and average capture cross sections. (J.W.R.)

13428 INTERNAL IONIZATION DURING ELECTRON CAPTURE. Stephas, Paul (Univ. of British Columbia, Vancouver). Phys. Rev.; 186: 1013-20(20 Oct 1969).

When an atom decays by K capture, the K shell will be left completely vacant if the second K electron is ejected from the atom (internal ionization) or makes a transition to an unoccupied bound state (internal excitation). Relativistic and nonrelativistic calculations are presented which describe internal ionization for both allowed and forbidden decays; the results are compared with those of previous theories and with pertinent experimental results. Evidence is provided that the total probability for internal ionization can be calculated from the nonrelativistic theory, while the spectral shape is described by the relativistic theory. The total probability calculated from the relativistic theory is larger than values obtained from experiment, owing to an overly simplified representation for the Coulomb screening and spatial corrections of the two K electrons in the parent atom. The shape of the ejected-electron spectrum depends on the degree of forbiddenness of the electron-capture transition, and therefore may be analyzed to provide new information for nuclear spectroscopists. (auth)

13429 HIGHER-ORDER EFFECTS IN ELECTRON–NUCLEUS SCATTERING. Toepffer, Christian; Greiner, Walter (Univ. of Virginia, Charlottesville. Univ., Frankfurt am Main). Phys. Rev.; 186: 1044-59(20 Oct 1969).

Higher-order effects are calculated in the framework of the eigenchannel theory for elastic and inelastic electron–nucleus scattering in the energy region $100 \leq E \leq 250$ MeV. A dispersion effect of about 12% is found for the elastic scattering on ^{58}Ni at a momentum transfer $q \approx 500$ MeV/c. For inelastic scattering, the reorientation effect is discussed, in addition to the dispersion effect. The total higher-order effect changes the form factor for a hindered first-order transition by 50% at its minima. Furthermore, the dependence of the higher-order effects on the transition potentials of the virtual excitations, the model dependence, and the dependence on the energy E of the electron and the momentum transfer q are discussed. A closed formula for the S matrix is developed by calculating the eigenchannels in stationary perturbation theory. (auth)

13430 UNITARY POLE APPROXIMATION AND BINDING ENERGY OF THE TRINUCLEON. Brady, T.; Fuda, M.; Harms, E.; Levinger, J. S.; Stagat, R. (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Rev.; 186: 1069-77(20 Oct 1969).

The unitary pole approximation (UPA) uses the two-body binding energy and wave function to determine the form factor for the UPA separable t matrix. The UPA is developed for Tabakin's 1965 spin-independent model potential for the trinucleon, and a trinucleon energy within 0.2 MeV of his result is obtained. Then the UPA for Tabakin's 1964 spin-singlet potential, and for the Schrenk–Mitra singlet is developed. These are combined with Yamaguchi shapes and also a modified Huthén shape for the spin-triplet central and tensor potentials. These choices give trinucleon energies within 0.3 MeV of the experimental value, provided that the deuteron has 4% D state. The dependence of trinucleon energy on the percent D state in the range $0.78\% \leq P_D \leq 7\%$ is studied. Tabakin's recent rank-1 separable fit to singlet phase shifts is also used. This separable potential gives a trinucleon energy 1.5 MeV higher than the singlet choices above because of its relatively weak attraction in off-shell t-matrix elements. (auth)

13431 SEPARABLE t MATRICES AND THE THREE-BODY PROBLEM. Fuda, Michael G. (State Univ. of New York, Buffalo). Phys. Rev.; 186: 1078-85(20 Oct 1969).

A new, separable expansion of the two-body t matrix is presented. Such an expansion reduces the Faddeev equations to coupled equations in one continuous variable. The leading term of the expansion is the separable approximation suggested by Kowalski and Noyes. Any separable approximation to the t matrix obtained by truncating the expansion is exact half-off the energy shell, exactly satisfies the off-shell unitarity relation, and duplicates the exact t matrix in the neighborhood of two-body bound-state and resonance energies. The rate of convergence of the expansion is tested by means of examples. Two terms give a good approximation to the S-wave part of the t matrix arising from a square-well potential, which fits the low-energy two-nucleon scattering data in an average way. It is also shown that the first term of the expansion gives a very good approximation to the t matrix arising from a pure hard-core potential. Results are given for the binding energy of a system of three identical spinless particles interacting via square-well potentials with and without hard cores. The two potentials have the same scattering length and effective range. The potential without a core produces a three-body binding energy of 10.1 MeV; the potential with a core produces a three-body binding energy of 8.00 MeV. (auth)

13432 THE INTERNAL BREMSSTRAHLUNG ACCOMPANYING THE β DECAY OF RADIOACTIVE NUCLEI. Hock, Gabor (Inst. for Nuclear Research, Debrecen, Hungary). Fiz. Szemle; 19: 198-202(Jul 1969). (In Hungarian).

The internal bremsstrahlung which accompanies the β^- emission was first discovered by Astom in 1927 in the RaE (^{210}Bi)β^- decay and was subjected to theoretical study by Knipp, Uhlenbeck and Bloch; this so-called KUB theory neglects the effect of the charge. Several other theories have been advanced later. All radiative β decay processes may be treated in a uniform manner on the basis of the field theory. The electromagnetic interaction plays a perturbing role in the β decay, creating the photon in the second-order radiative decay in addition to other final particles. The goal of the calculations is to determine the transition probability or the γ spectrum of the radiative decay. The theoretical studies are illustrated on the decay of ^6He, in which the Coulomb interaction may be neglected. In the case of ^{32}P considerable differences were found between the experimental data and theoretical predictions. In the forbidden β^- decays the nuclear radiation must be taken into account as the continuous γ intensities are higher than expected by the corrected Coulomb theory (^{90}Y, ^{91}Y, ^{204}Tl, ^{42}K, etc.). In the β^+ decay the annihilation γ radiation of positrons must also be taken into account. (TTT)

13433 GENERALIZED PORTER–THOMAS DISTRIBUTION FOR RESONANCE WIDTHS. Lukyanov, A. A.; Sheker, M. O. (Atomic Energy Commission, Cairo). Yadern. Fiz.; 10: 790-3 (Oct 1969). (In Russian).

Distribution of the resonance widths for many-channel reactions is obtained in the framework of the Porter–Thomas statistical method for arbitrary fractional contributions of various channels to the averaged widths. Experimental distribution of the fission widths of the ^{235}U neutron resonances is analyzed. For both of the two possible values of the total angular momentum the following quantities are estimated: averaged fission widths, fission channel number, and their fractional contribution with account of a possible $(n,\gamma f)$ process. (auth)

13434 ON EXISTENCE OF EXTREMA DUE TO FEYNMAN GRAPHS IN ENERGY SPECTRUM OF BREMMSSTRAHLUNG γ QUANTA AND NEW POSSIBILITIES TO IDENTIFY THE MECHANISM OF NUCLEAR REACTIONS. Dubovoi, E. I. (Radiotechnical Inst., Moscow). Yadern. Fiz.; 10: 781-9(Oct 1969). (In Russian).

It is shown that both spectra of finite products of multiparticle

nuclear reactions and spectra of internal bremsstrahlung γ quanta emitted in multiparticle and binary nuclear reactions must contain irregularities corresponding to the square-root and logarythmic singularities of the amplitude. The observation of these irregularities allows one to establish experimentally the mechanism of the process. (auth)

13435 α-PARTICLE MODEL AND ELECTRON SCATTERING OF ORIENTED NUCLEI. Tishchenko, B. I.; Kresnin, A. A. (Physical-Technical Inst., Kharkov). Yadern. Fiz.; 10: 766-70(Oct 1969). (In Russian).

Electron scattering of oriented nuclei is considered on the basis of the α-particle model. General expressions are obtained that determine cross sections of elastic and inelastic scattering with excitation of rotational nuclear levels. It is shown that the electron scattering of oriented nuclei enables one to determine the sign of the deformation of the nuclei. (auth)

13436 LONG-RANGE PART OF EFFECTIVE INTERACTION OF QUASIPARTICLES IN NUCLEI. Sapershtein, E.; Khodel, V. A. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 10: 744-54(Oct 1969). (In Russian).

The long-range part of the quasiparticle pair interaction amplitude Γ which plays the role of effective potential of interection in the problem of spectra of low-lying excitations on nuclei close to magic is considered. It is shown that long-range forces appear in those perturbation theory diagrams for Γ which have parts connected by only two lines corresponding to the expansion of a pair particle-particle or particle-hole. It is found that the interaction amplitude Γ, together with nonuniversal varying from nucleus to nucleus interaction, has the universal long-range part which is due to the contribution of states far from the Fermi surface in the particle-particle channel. Its role is of special importance in the case when the moment J of an interacting particle pair is close to zero, in particular, when considering the pairing problem in nuclei. The contribution of long-range parts of Γ to various two-particle matrix elements of the interaction amplitude is considered. (auth)

13437 β DECAY INTO COLLECTIVE LEVELS OF SPHERICAL NUCLEI. Batkin, I. S.; Kopytin, I. V.; Rapoport, L. P. (Voronezh State Univ., USSR). Yadern. Fiz.; 10: 737-43(Oct 1969). (In Russian).

Probabilities of β transitions into the ground and the first excited 2^+ state of even-even spherical nuclei in the region of $62 \leq A \leq 82$ are considered in terms of the theory of finite Fermi systems. Calculations of lg f_0t for the β transitions and for frequencies of corresponding collective excitations are performed. Reasonable agreement with experiment is obtained. (auth)

13438 OPTICAL POTENTIALS OF COMPOSITE PARTICLES. Kadmenskii, S. G.; Kalechits, V. E.; Lopatko, S. I.; Furman, V. I.; Khlebostroev, V. A. (Voronezh State Univ., USSR). Yadern. Fiz.; 10: 730-6(Oct 1969). (In Russian).

Optical potentials of composite particles (OPCP) are obtained starting from the phenomenological one-nucleon optical potentials. Radial dependence of the real parts of the OPCP is not of the standard Woods-Saxon form. However, it may be described by the modified W.-S. function with the diffusion parameter depending on the radius. The obtained OPCP are applied to the analysis of experiments on elastic α-particle scattering. The satisfactory agreement between theory and experiment enables one to consider the OPCP as a reasonable basis for detail analysis of the elastic scattering of composite particles. (auth)

13439 AVERAGE NUCLEAR PROPERTIES. Myers, William D.; Swiatecki, W. J. (Univ. of California, Berkeley). Ann. Phys. (N.Y.); 55: 395-505(Dec 1969).

A generalized treatment of average nuclear properties is presented. The theory is developed on two levels: First a refinement of the Liquid Drop Model, called the Droplet Model, is described. The degrees of freedom in this model, in addition to the usual shape variables, are variables specifying deviations from uniformity of the neutron and proton densities. Minimizing the Droplet Model potential energy with respect to density variations leads to equations, in closed form, specifying the separate neutron and proton radii and the density nonuniformities. The minimized energy expression leads to a refined Droplet Model Mass Formula with nine parameters. The second level at which average nuclear properties are treated is based on assuming a concrete model of a two-component saturating system, consisting of neutrons and protons interacting by velocity-dependent Yukawa forces (and Coulomb forces). When this model is treated in the Thomas-Fermi approximation a pair of coupled integral equations results, which can be used as the basis of a self-contained model of all average static nuclear properties. The applications of the Droplet Model and Thomas-Fermi Model discussed include predictions concerning neutron and proton radii (in particular the presence of a neutron skin), the isotope effect in proton radii, the compression of the nucleus by the surface tension and the dilatation by the Coulomb energy, and the central depression in the densities caused by the Coulomb repulsion. Calculations are made for the surface curvature correction, for the surface symmetry energy, and for a modification to the volume symmetry energy at a large neutron excess. A revised estimate is made for the value of the symmetry energy of nuclear matter. Also treated is the question of whether or not neutron matter is bound, and some discussion is given of the spatial distribution, the energy dependence, and the composition dependence to be expected for nuclear optical model potentials on the basis of the statistical methods used. (auth)

13440 EFFECTIVE INTERACTIONS AND COLLECTIVE VIBRATIONS. Zamick, Larry (Rutgers-The State Univ., New Brunswick, N. J. Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev. Lett., 23: 1406-8(15 Dec 1969).

The calculated contribution of core polarization to the effective interaction between two nucleons in a nucleus is shown, for certain potentials, to be much larger in the random-phase approximation than in first-order perturbation theory. Collective quadrupole and (in one case) monopole excitations are responsible for this. (auth)

13441 NECESSARY CONDITIONS FOR SATURATION OF NUCLEAR FORCES. Calogero, F. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome); Simonov, Yu. A. Nuovo Cim.; 64B: 337-54(11 Dec 1969).

Rigorous conditions are written down, that must be satisfied by the nuclear interaction in order to be consistent with saturation. They apply to general potential shapes (possibly different in different spin-isospin states). The treatment includes direct, exchange, tensor and spin-orbit interactions described by two-body local velocity-independent potentials. (auth)

13442 DIRECT INTERACTIONS IN NUCLEAR REACTIONS. I. Vladuca, G. (Univ., Bucharest). Stud. Cercet. Fiz., 21: 197-242(1969). (In Rumanina).

The large number of studies on the theory of nuclear reactions carried out during the last decade—initially on (d,p) and (d,n) reactions—indicated that the compound nucleus model is not sufficient to explain the observed phenomena. The postulated new model of interaction involves direct passage from the initial to the final state and obviates the need to study the intermediate states of the compound nucleus. In comparison with the latter, the direct interactions involve specific properties of differential cross section, polarization and angular correlation characterized by the level spins and parities of the participating nuclei. Use of this concept in nuclear spectroscopy is illustrated on the basis of concrete examples; the importance of the transition amplitude is emphasized. A general expression is presented for the differential cross section; indicating the special features of inelastic scattering, stripping, knock-out and pick-up reactions. The implications of the unified model are discussed by separating the "internal" and "collective" motions of the nucleons. (TTT)

13443 SCATTERING BY NUCLEI AT HIGH ENERGIES. Feshbach, H.; Huefner, J. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Ann. Phys. (N. Y.); 56: 268-94(Jan 1970).

Nucleon-nucleon correlations influence on high-energy scattering by nucleus is studied. Using the multiple scattering theory of Kerman, McManus, and Thaler, the scattering problem is formulated in terms of an infinite system of coupled equations. For the calculation of elastic scattering, it is proposed replacing the infinite system by a pair of coupled equations, containing the elastic channel, and another effective one which carries the inelastic strength. The coupling potential is proportional to the nuclear pair correlation function, and a first approximation to the potential is obtained. These equations are accurate to the extent that the pair correlations and not higher-order correlations are important. There are no restrictions to forward scattering, nor are any "on the energy shell" approximations made. In order to obtain insight into the structure of the many-channel S-matrix for high energies, the infinite system of coupled equations is solved by semi-classical methods, and explicit formulas for the S-matrix elements as a function of various potentials and the nuclear pair correlation function are obtained. It is shown how properties of excited target states may complicate a reliable extraction of correlations in high-energy scattering by nuclei. A close relation between the semiclassical solution and Glauber's multiple scattering is established. A numerical study of high-energy nucleon-nucleus scattering using the methods developed is under way. (auth)

REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstracts 11469, 11727, and 13531.

13444 (BARC–439) THEORETICAL ANALYSIS OF THE PHYSICS CHARACTERISTICS OF THE TARAPUR CORE. Balakrishnan, M. R. (Bhabha Atomic Research Centre, Bombay (India)). 1969. 32p. Dep. CFSTI (U. S. Sales Only).

Physics parameters of the boiling light water reactors at Tarapur were estimated by means of a four group formalism. Two group parameters at various conditions of the core and results of burnup analysis are given. Void coefficients and temperature coefficients of reactivity are also given. (14 references) (auth)

13445 (DOCKET-1155–18) MALFUNCTION OF DIESEL FIRE PUMP 1B. LACBWR Incident Report No. DPC 70-1. (Dairyland Power Cooperative, La Crosse, Wis.). 23 Jan 1970. 4p. Dep. CFSTI.

The malfunction of the diesel pump in the high pressure service water system is described. The results of the failure of the diesel pump to start at the 60 psig setpoint in the automatic mode are discussed. Subsequent events are evaluated; the necessary corrective actions on the part of operations personnel are specified. (M.L.S.)

13446 (DOCKET-50010–64) DRESDEN NUCLEAR POWER STATION, [UNIT 1]. Annual Report of Station Operation for the Year 1969. (Commonwealth Edison Co., Chicago, Ill.). 21 Jan 1970. 52p. Dep. CFSTI.

13447 (DOCKET-50130–4) PATHFINDER GENERATING PLANT. [Preliminary Safety Analysis Report], Amendment 49. (Northern States Power Co., Minneapolis, Minn.). 4 Feb 1970. 4p. Dep. CFSTI.

A license extension to allow the development of a decommissioning plan for the reactor and associated systems is requested. A brief description of the present state of the reactor is included. (M.L.S.)

13448 (DOCKET-50133–25) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. Failure Mode Analysis of Reactor Protection Systems. (Pacific Gas and Electric Co., San Francisco, Calif.). 20 Jan 1970. 65p. Dep. CFSTI.

A detailed failure mode analysis of the Humboldt Bay Power Reactor protection systems is given. Analyses are detailed for: the reactor safety system–sensor to logic units, logic units, power switches, and 115 volt a-c safety bus; liquid poison system; and reactor engineered safeguards systems. (M.L.S.)

13449 (DOCKET-50155–19) [BIG ROCK POINT NUCLEAR PLANT]. Power Reactor High Performance UO_2 Program. Analysis of Fission Product Release Related to Centermelt Fuel Failures. (General Electric Co., San Jose, Calif. Nuclear Fuels Dept.). Jun 1969. Contract AT(04-3)-189. 17p. Dep. CFSTI.

For Consumers Power Co., Jackson, Mich.

Center-melt failure of Big Rock Point Power Reactor fuel elements while operating at 27 kW/ft is described. Detailed analyses of the fission gas release during the last seven days of reactor operation are given; data are shown graphically and in tabular form. (M.L.S.)

13450 (DOCKET-50155–20) [BIG ROCK POINT NUCLEAR PLANT]. Power Reactor High Performance UO_2 Program. Final Report. Progress Report No. 10, April 1–June 30, 1969. (General Electric Co., San Jose, Calif. Nuclear Fuels Dept.). Jun 1969. Contract AT(04-3)-189. 31p. Dep. CFSTI.

For Consumers Power Co., Jackson, Mich.

Program highlights of the high performance UO_2 centermelt fuel irradiation program in the Big Rock Point Power Reactor are summarized as of June 30, 1969. Program background and scope are outlined. The high performance fuel bundles are described. First cycle operation is discussed; results are summarized. Failure analyses and results of thermal-hydraulic loop tests are outlined. (M.L.S.)

13451 (DOCKET-50155–21) [BIG ROCK POINT NUCLEAR PLANT]. [Installation of a Control Rod Drive Support Structure]. (Consumers Power Co., Jackson, Mich.). 23 Jan 1970. 4p. Dep. CFSTI.

A description is given of the proposed control rod drive support structure which is to be installed in the Big Rock Point Power Reactor. A design change relating to the Belleville washer characteristics is described. (M.L.S.)

13452 (DOCKET-50155–22) BIG ROCK POINT NUCLEAR PLANT. License No. DPR-6. Additional Information for Proposed Technical Specifications Change No. 19. (Consumers Power Co., Jackson, Mich.). 28 Jan 1970. 11p. Dep. CFSTI.

Additional details on the blended PuO_2–UO_2 fuel proposed for irradiation in the Big Rock Point Power Reactor are given. Transient behavior and particle size characterization of the fuel material is detailed. Results of SPERT tests with the PuO_2–UO_2 fuels are outlined. Pu particle size distribution in the fuels and the effects of this distribution are discussed. The effects of changes in effective delayed neutron fraction β_{eff} on reactivity accidents are analyzed in detail; peak enthalpy ratio is shown as a function of effective delayed neutron fraction. (M.L.S.)

13453 (DOCKET-50171–22) [PEACH BOTTOM ATOMIC POWER STATION, UNIT 1]. [Preliminary Safety Analysis Report], Amendment 16. (Philadelphia Electric Co., Pa.). 28 Jan 1970. 5p. Dep. CFSTI.

Changes in the license of the Peach Bottom Power Reactor, Unit 1 are noted to reflect possession changes in amounts of ^{235}U, ^{238}U, and ^{232}Th. (M.L.S.)

13454 (DOCKET-50206–42) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. [Preliminary Safety Analysis Report], Amendment 17. (Southern California Edison Co., Los Angeles). 9 Feb 1970. 7p. Dep. CFSTI.

An extension of the provisional operating license for San Onofre Power Reactor is requested. The general status of the low power testing program and associated documentation is outlined. (M.L.S.)

13455 (DOCKET-50213–25) REACTOR AND PLANT PERFORMANCE ENGINEERING TESTS AND MEASUREMENTS. Addendum Report in Support of Connecticut Yankee Full Term Operating License Application. (Connecticut Yankee Atomic Power Co., Haddam). Oct 1969. 126p. Dep. CFSTI.

The results of engineering tests and measurements at the Connecticut Yankee Power Reactor are detailed. The program is described from initial core loading through October 1969. Inverse count-rate data and loading diagrams are shown for the initial core loading. Precritical testing is discussed. Control rod worth measurements are described; differential and integral rod worth curves are included for Banks A, B, C, and D; data are tabulated for dropped rods, stuck rods, and ejected rods. Moderator reactivity coefficient measurements are described; data are presented in both tabular and graphic form. Results of reactivity worth measurements of reactor coolant boron are analyzed. Core power distribution measurements and analyses are detailed; in-core instrument locations are shown; measured and predicted hot channel factors are compared. Neutron flux maps are shown for the unrodded core. Heat balance measurements are described; data are given. Xenon oscillation tests are described; reactor behavior is analyzed. Mass and energy balances for thermal power and core burnup analyzers are discussed; data are tabulated. Experimental determination of three-loop operation effects is described; data are included. Increase of power from 1473 MW(t) to 1825 MW(t) is described; results of coolant flow measurements, primary system natural circulation measurements, and plant performance evaluations are detailed. (M.L.S.)

13456 (DOCKET-50213–26) [CONNECTICUT YANKEE ATOMIC POWER PLANT]. Supporting Information for Full Term Operating License Application. (Connecticut Yankee Atomic Power Co., Haddam). Dec 1969. 119p. Dep. CFSTI.

The operations history of the Connecticut Yankee Power Reactor is summarized; the operations difficulties and system-component malfunctions are described with the corrective actions specified. Proposed Technical Specifications changes and plant design changes are summarized. Primary and containment systems surveillance programs are discussed. The organizational structure for the Connecticut Yankee Plant is shown; staffing requirements, training, and retraining are discussed. Compliance with overall plant design criteria and with IEEE standards for nuclear power plant construction are discussed. Adequacy of the Emergency Core Cooling Systems, containment, emergency power system, and reactor protection system is considered. (M.L.S.)

13457 (DOCKET-50220–33) NINE MILE POINT NUCLEAR STATION. Primary and Secondary Containment Leak Test. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 19 Jan 1970. 16p. Dep. CFSTI.

Details of the primary and secondary containment leak rate tests at the Nine Mile Point Power Reactor are given. Specifications, acceptance criteria, and test procedures are given. Results are tabulated; calculations are shown. Changes in reference-to-drywell and reference-to-torus are shown as functions of time. Secondary containment integrated leak test data are tabulated. (M.L.S.)

13458 (DOCKET-50220-34) NINE MILE POINT NUCLEAR STATION, UNIT NO. 1. Environmental Pre-Operational Survey. (Niagara Mohawk Power Corp., Syracuse, N. Y.). Dec 1969. 36p. Dep. CFSTI.

13459 (DOCKET-50244-29) BROOKWOOD NUCLEAR STATION, UNIT NO. 1. Third Supplement to Preliminary Facility Description and Safety Analysis Report, [Amendment 3]. (Rochester Gas and Electric Corp., N. Y.). 28 Feb 1966. 187p. Dep. CFSTI.

Name changed later to Robert Emmett Ginna Nuclear Power Plant, Unit 1.

Temperatures of the dome and steel liners for the Robert E. Ginna Power Reactor, Unit 1 containment vessel are given as functions of time under MCA conditions. Safety margins for seismic loadings of steam generator components are given: Post-accident containment-vessel condition monitors are listed. DNB ratios and calculations of number of rods to reach DNB are given. Blowdown is analyzed in detail; effects on the containment system are evaluated. Operation of the residual heat removal system under post-accident conditions are discussed; details of containment penetrations and isolation valves are given; the operation and design of the recirculation loop and safety injection systems are analyzed in detail. The fan-cooler-filter system for the containment is described; reliability margins are given. Characteristics of the charcoal filter beds are detailed. Fast neutron doses to the pressure vessel are estimated; radiation- and temperature-induced effects on NDTT are discussed. Uncertainties in containment pressure calculations are specified. The relation of the Ginna plant to Lake Ontario is discussed. (M.L.S.)

13460 (DOCKET-50244-35) [ROBERT] GINNA STATION, UNIT NO. 1. Safety Injection Pump Surveillance Requirement. Application for Revision of Technical Specifications. (Rochester Gas and Electric Corp., N. Y.). 11 Jan 1970. 5p. Dep. CFSTI.

13461 (DOCKET-50244-36) [ROBERT] GINNA STATION, UNIT NO. 1. Failure of One Safety Injection Train to Operate on Signal. (Rochester Gas and Electric Corp., N. Y.). 12 Jan 1970. 3p. Dep. CFSTI.

13462 (DOCKET-50244-37) [ROBERT] GINNA STATION, UNIT NO. 1. Violation of Containment Integrity, January 9, 1970. (Rochester Gas and Electric Corp., N. Y.). 19 Jan 1970. 2p. Dep. CFSTI.

13463 (DOCKET-50244-39) ROBERT E. GINNA NUCLEAR POWER STATION, [UNIT 1]. Structural Integrity Test of Reactor Containment Structure. (Gilbert Associates, Inc., Reading, Pa.). 3 Oct 1969. 205p. Dep. CFSTI.

For Rochester Gas and Electric Corp., N. Y.

Details of the testing of the structural integrity of the Robert E. Ginna Power Reactor, Unit 1 are given. The containment structures are described, generally; construction methods are explained. Test requirements for the containment system are outlined. Test procedures, instrumentation, as-built conditions, and calculated response are discussed. Displacements and stresses from measured displacements are described; stress determinations from measured strain values are discussed. Crack patterns are evaluated. Integrity of tendon anchorages is discussed. Instrument locations around the containment structures are tabulated as a function of position. All data from the tests are shown graphically or tabularly. (M.L.S.)

13464 (DOCKET-50247-14) [INDIAN POINT NUCLEAR GENERATING UNIT NO. 2]. [Preliminary Safety Analysis Report], Amendment 14. (Consolidated Edison Co. of New York, Inc., New York). 27 Jan 1970. 136p. Dep. CFSTI.

Stress analyses and results of Charpy V-notch tests for the Indian Point Power Reactor, Unit 2 pressure vessel are outlined. Quality assurance procedures for the electroslag welding of Class I components are listed. Provisions for analyzing primary coolant boron concentration are described. Detailed analyses of exposure dose from effluents from all three units are given. Emergency plans for earthquakes, fires, tornadoes, and radiation incidents are detailed; the emergency notification roster and organizational chart are included. (M.L.S.)

13465 (DOCKET-50255-23) PALISADES PLANT. [Preliminary Safety Analysis Report], Amendment 19. (Consumers Power Co., Jackson, Mich.). 15 Jan 1970. 32p. Dep. CFSTI.

Changes in materials for the Palisades Power Reactor ECCS equipment and components are listed. Respiratory protection equipment which is intended for use is described; protection factors for the respiratory equipment are tabulated. Containment building venting under post-accident conditions is discussed. Materials within the containment which are subject to corrosion by ECCS sprays are tabulated. Detailed data on corrosion of the aluminum and hydrogen accumulation caused by aluminum corrosion are given. (M.L.S.)

13466 (DOCKET-50261-20) H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2. [Preliminary Safety Analysis Report], Amendment 14. (Carolina Power and Light Co., Raleigh, N. C.). 23 Jan 1970. 86p. Dep. CFSTI.

Revised or additional information is given on the containment systems and structures design for the H. B. Robinson Power Reactor, Unit 2. A quantitative evaluation of the ECCS design is given. Effects of shock or pressure waves on the containment air recirculation ductwork under coolant loss accident conditions are analyzed. Effects of off-site power losses are evaluated; load schedules are tabulated for loss of off-site power with concurrent turbine generator trip. The penetration pressurization system which is designed to continuously monitor containment leakage is described; containment penetrations are tabulated. (M.L.S.)

13467 (DOCKET-50266-16) POINT BEACH NUCLEAR PLANT, UNIT NO. 1 AND 2. Final Facility Description and Safety Analysis Report, Amendment 2, Vol. 5. (Wisconsin Electirc Power Co., Milwaukee. Wisconsin Michigan Power Co., Appleton, Wis.). 30 Jan 1970. 456p. (DOCKET-50301-13). Dep. CFSTI.

Reactivity requirements for the Point Beach Power Reactor, Unit 2 are tabulated. Calculated rod worths and normalized power densities are given; Doppler coefficient is shown as a function of resonance effective temperature. Results of the high power fuel rod experimental program are described; data are shown graphically. Possibilities for missile generation from primary pump flywheels are analyzed. The quality assurance program for the cooling system is tabulated. Operating conditions for residual heat removal system are given; design modifications for the safety injection system are shown. A single failure analysis of the containment spray system is given. Results of the fuel rod evaluation program are described with respect to clad perforation and deformation. A load-loss transient is performed assuming the reactor does not scram under any of the successive trip signals. Effects of transient conditions on cooling system equipment are evaluated. Methods for stress analyses of core and internals are described. Storage conditions and delivery lines for the concentrated sodium hydroxide core spray additive are discussed; corrosion rates of system components are considered. Design bases and criteria for reactor protective systems are discussed; cable installation criteria are described. Responsibilities of key supervisory personnel are delineated; training received by all plant personnel is described. The emergency plan for the plant is discussed. Acceptance criteria for post-neutron tests are tabulated. Models used to simulate the core, main coolant loop, and internals in blowdown calculations are described. Potential hydrogen evolution over the post-coolant loss accident period is analyzed. (M.L.S.)

13468 (DOCKET-50269-11) OCONEE NUCLEAR STATION, [UNITS 1, 2, AND 3]. [Preliminary Safety Analysis Report], Amendment 9. (Duke Power Co., Charlotte, N. C.). 9 Feb 1970. 104p. (DOCKET-50270-11; DOCKET-50287-8). Dep. CFSTI.

The completely revised quality assurance program for the Oconee Power Reactor, Units 1, 2 and 3 is given. Revised population distributions are shown as a function of radial sector for the 1965-2010 period. Details relating to the 125 volt d-c and the 240/120 volt a-c systems are given; single failure analyses are included. (M.L.S.)

13469 (DOCKET-50277-7) PEACH BOTTOM ATOMIC POWER STATION. Environs Radiation Monitoring Program. Operational Report No. 4, January 1-December 31, 1966. (Nuclear Science and Engineering Corp., Pittsburgh, Pa.). Jun 1967. 76p. (DOCKET-50278-7; NSEC-132). Dep. CFSTI.

For Philadelphia Electric Co., Pa.

13470 (DOCKET-50277-8) [PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3]. Pre-Operational Environs Radioactivity Survey. Summary Report, March 1960-January

1966. (Nuclear Science and Engineering Corp., Pittsburgh, Pa.). Sep 1967. 40p. (DOCKET-50278-8; NSEC-133). Dep. CFSTI.
For Philadelphia Electric Co., Pa.

13471 (DOCKET-50280-23) SURRY POWER STATION, UNITS 1 AND 2. [Preliminary Safety Analysis Report], Amendment 13, Part A. (Virginia Electric and Power Co., Richmond). 9 Feb 1970. 89p. (DOCKET-50281-23). Dep. CFSTI.

The revised license application for the Surry Power Reactor, Units 1 and 2 is presented. The by-laws and articles of incorporation of the Virginia Electric and Power Company (VEPCO), the proposed stock issue, and the proposed bond levy for financing VEPCO operations are included. (M.L.S.)

13472 (DOCKET-50282-18) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Load Test of Beams at Mezzanine Floor Level. (Northern States Power Co., Minneapolis, Minn.). 4 Feb 1970. 72p. (DOCKET-50306-18). Dep. CFSTI.

Load tests of beams at the fire-damaged mezzanine floor level of the Prairie Island Power Reactor, Units 1 and 2, are discussed. Test procedures and results are detailed; raw data are tabulated. The complete report of the Twin City Testing and Engineering Laboratory, Inc. is included. (M.L.S.)

13473 (DOCKET-50305-6) KEWAUNEE NUCLEAR POWER PLANT. [Preliminary Safety Analysis Report], Supplementary Information. (Wisconsin Public Service Corp., Green Bay). 15 Jan 1970. 64p. Dep. CFSTI.

Design details for the Kewaunee Power Reactor containment system are discussed; information is given on: piping penetrations using the guard pipe, seismic design of large penetrations such as the steam pipe and personnel airlock, limitations on deformation of the shield building and connected systems, and vacuum relief values. Special design procedures include the structures and systems classification schemes, design codes, load factors, and structural design bases. A listing of the classification for all structures and components is included. Details of the electrical system design are given; network interconnections, auxiliary electrical system, and emergency power sources are described. (M.L.S.)

13474 (DOCKET-50312-15) RANCHO SECO NUCLEAR GENERATING STATION, UNIT NO. 1. Answers to DRL Questions and Supplemental Information on VSL Tendon System. (Sacramento Municipal Utility District, Calif.). 2 Feb 1970. 787p. Dep. CFSTI.

The VSL anchorage system for the Rancho Seco Power Reactor, Unit 1 containment and reactor buildings is discussed; compliance of the VSL system with ACI–ASCE Committee 423 standards is considered. Details of static tests on the VSL strand tendons are given; data are included in either graphic or tabular form. Relative strains and stresses on the strand bearing plate are evaluated. Results of low temperature and cyclic tests on the VSL anchorages are analyzed. Effects of manufacturing and field variables are evaluated; results of friction tests are given. The VSL quality assurance program is detailed; hardware drawings are shown. Specifications and requirements for bearing plate, anchor head, and wedge steels are detailed; strand material specifications are given. Corrosion testing and procedures are discussed. (M.L.S.)

13475 (DOCKET-50313-18) [ARKANSAS NUCLEAR ONE]. Preliminary Safety Analysis Report, Amendment 15. (Arkansas Power and Light Co., Little Rock). 7 Jan 1970. 8p. Dep. CFSTI.

Anchorage zone reinforcing in the buttress of the Arkansas Nuclear One Power Reactor is described. Diagrams show the buttress plan and horizontal and radial reinforcing. (M.L.S.)

13476 (DOCKET-50322-17) SHOREHAM NUCLEAR POWER STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 11. (Long Island Lighting Co., Mineola, N. Y.). 30 Jan 1970. 6p. Dep. CFSTI.

Revised information related to pipe movement due to pipe failures is presented. Effects on containment system integrity of failure actuated pipe movements are analyzed. (D.C.C.)

13477 (DOCKET-50327-15) SEQUOYAH NUCLEAR PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 9. (Tennessee Valley Authority, Chattanooga. Office of Power). 30 Dec 1969. 61p. (DOCKET-50328-15). Dep. CFSTI.

Revised or additional information is given on Sequoyah Power Reactor, Units 1 and 2. Details relating to the 120 volt a-c vital instrument bus system are given; the 250 volt d-c system is discussed. A failure analysis for the emergency power system is given. New values for off-site dispersion factors and inhalation- and whole-body doses subsequent to a maximum hypothetical accident are tabulated. A preliminary outline of a radiological emergency plan is included. (M.L.S.)

13478 (DOCKET-50329-8) [MIDLAND PLANT, UNITS 1 AND 2]. Preliminary Safety Analysis Report, Amendment 5. (Consumers Power Co., Jackson, Mich.). 29 Dec 1969. 353p. (DOCKET-50330-8). Dep. CFSTI.

The quality assurance program plan for the Midland Power Reactor, Units 1 and 2 is detailed. Methods to be used for seismic analyses of reactor internals are described. Tornado loading effects on Class I structures are discussed; calculated values are given. Support structures for Class I equipment within the containment vessel are described. Soils characteristics and their relation to Class I structures are discussed. Soil settlements and conditions for settlement are described. Estimated projections of radioactivity releases are given on a daily and an annual basis. Effects of a hypothetical accident with a full pressurizer on primary system integrity are considered. The preliminary design for control room shielding is described. A detailed geology, seismicity, and hydrology study for the Midland site is included. (M.L.S.)

13479 (DOCKET-50331-18) DUANE ARNOLD ENERGY CENTER. [Preliminary Safety Analysis Report], Amendment 11. (Iowa Electric Light and Power Co., Cedar Rapids). 2 Jan 1970. 150p. Dep. CFSTI.

The license application for Iowa Electric Light and Power Company's Duane Arnold Power Reactor is amended to include other utilities. Iowa Electric's 1968 Annual Report is included, as are the Annual Reports for the new co-owners, Central Iowa Power Company and Corn Belt Power Cooperative. The ownership participation agreement is presented. (M.L.S.)

13480 (DOCKET-50331-19) DUANE ARNOLD ENERGY CENTER. Preliminary Safety Analysis Report, Amendment 13. (Iowa Electric Light and Power Co., Cedar Rapids). 8 Jan 1970. 15p. Dep. CFSTI.

A preliminary analysis of the pressure vessel support structure for the Duane Arnold Power Reactor is given; data on response spectra and acceleration are shown graphically. A general seismic analysis of Class I piping and the torus is included. (M.L.S.)

13481 (DOCKET-50333-15) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Preliminary Safety Analysis Report, [Amendment 11]. (Power Authority of the State of New York). 15 Jan 1970. 27p. Dep. CFSTI.

Details of the quality assurance program for the James A. Fitzpatrick Power Reactor are given; these details include the outline of the program, organization of personnel for program execution, and qualifications of these personnel. The working arrangements between the Power Authority of the State of New York and Niagara Mohawk are delineated. The operational organization and associated responsibilities are outlined. (M.L.S.)

13482 (DOCKET-50333-16) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Preliminary Safety Analysis Report, [Amendment 12]. (Power Authority of the State of New York). 15 Jan 1970. 35p. Dep. CFSTI.

A general outline of the organization for the design and construction of the James A. Fitzpatrick Power Reactor is presented. The design using forced paralleling of diesel generators for emergency power is described. Details relating to the flood study of Lake Ontario which adjoins the site are given.(M.L.S.)

13483 (DOCKET-50333-17) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Preliminary Safety Analysis Report, [Amendment 13]. (Power Authority of the State of New York). 23 Jan 1970. 26p. Dep. CFSTI.

A sequential tabulation of AEC comments relative to the James A. Fitzpatrick Power Reactor is given for Amendments 2 through 12. A sequential listing of PSAR sections referring to these comments is included also. (M.L.S.)

13484 (DOCKET-50334-14) BEAVER VALLEY POWER STATION. [Preliminary Safety Analysis Report], Amendment 12. (Duquesne Light Co., Pittsburgh, Pa.). 23 Jan 1970. 81p. Dep. CFSTI.

Soils stability analyses for the Beaver Valley Power Reactor site are discussed. Piping classifications are given. Loadings for the emergency buses are tabulated. The redesign of the supplementary leak collection and release system is described. (M.L.S.)

13485 (DOCKET-50335-11) [HUTCHINSON ISLAND PLANT, UNIT NO. 1]. [Preliminary Safety Analysis Report], Amendment 6. (Florida Power and Light Co.). 7 Jan 1970. 69p. Dep. CFSTI.

Containment penetrations and isolation values are listed for the Hutchinson Island Power Reactor, Unit 1. The method used for determination of seismic stresses on the reactor internals is described. Possibilities of containment leakage subsequent to an accident are considered. Hurricane surges are discussed; the evaluation of hurricane effects is detailed. (M.L.S.)

13486 (JPRS-49570) FIVE YEARS OF OPERATION OF THE NOVO-VORONEZHSKAYA ATOMIC POWER STATION. Ovchinnikov, F. Ya.; Voronin, L. M.; Golubev, L. I. Translated from At. Energ. (USSR); [27]: 274-80(Oct 1969). 11p. CFSTI.

The first unit of the NVAES (Novo-Voronezhskaya Atomnaya Energeticheskaya Stantsiya) was initially brought into the network and provided electrical current on 30 September 1964. After three months the electric power of the atomic power station was increased to its planned level of 210 MW. During the five years which followed the station reliably and with a high stability supplied electric power to the Voronezh electric power system. During operation of the atomic power station much experience was accumulated on ensuring nuclear safety, in perfecting engineering processes, etc. Experimental studies made at the station made possible a considerable improvement in its technical and economic indicators due to putting into use potentialities noted in the course of operation. An increase in the production of electric power, reduction in expenditures on servicing and repair of equipment, and economic consumption of nuclear fuel as a result of a more rational positioning of fuel assemblies during the next rechargings, improvement in the distribution of energy release in the core, and an increase in the run made it possible to achieve a considerable reduction in the cost of 1 kWh. (4 references) (auth)

13487 (STI/PUB-222) SAFE OPERATION OF NUCLEAR POWER PLANTS. Safety Series No. 31. Code of Practice and Technical Appendices. (International Atomic Energy Agency, Vienna (Austria)). Nov 1969. 132p. IAEA $4.00.

The Code of Practice for the Safe Operation of Nuclear Power Plants was prepared by the IAEA in cooperation with the World Health Organization. Under the code, organizations intending to operate a nuclear power plant are recommended to prepare documentation which would deal with its operation and include safety analyses. The documentation would be reviewed by a regulatory body independent of the operating organization. Operation would be authorized within limits and conditions designed to ensure safety. Appendices to the code provide additional technical information and illustrative examples relating to topics dealt with in the code. (H.D.R.)

13488 (TID-25291) KERNKRAFTWERK GUNDREMMINGEN (KRB) ANNUAL REPORT, 1968. (Kernkraftwerk RWE-Bayernwerk G.m.b.H., Gundremmingen (West Germany)). May 1969. 50p. Dep. CFSTI.

The operating history of the reactor and conventional plant components is summarized. Data are presented on the plant operation, electrical systems performance, physics, plant water chemistry, and operating costs. The year was marked by four major outages totaling 145 days, all caused by turbine defects. The history of these shutdowns and the maintenance carried out on the plant are described. (H.D.R.)

13489 (TID-25292) ARDENNES NUCLEAR POWER PLANT. Quarterly Report No. 29, July 1-September 30, 1969. (Societe d'Energie Nucleaire Franco-Belge des Ardennes, Chooz-lez-Givet (France)). 14 Nov 1969. 9p. Dep. CFSTI.

The following main events occurred in the period from 1 July to 30 September 1969: completion of repairs proper on reactor internals and reinsertion of the latter in pressure vessel; mounting of instrumentation necessary for checking the behavior of reactor internals both during loading and during dynamic testing; start of refuelling; completion of modifications to primary pumps and reassembly in the four loops; completion of repairs on steam generators; recommissioning of new system for signalling faults to control room. (auth)

13490 (TID-25293) GARIGLIANO NUCLEAR POWER PLANT. End of Construction Report. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). Aug 1965. 48p. Dep. CFSTI.

A summary of general information on the construction of the Garigliano nuclear power plant is presented, consolidating the information previously given. The information given concerns the construction programs, the problems encountered during construction, the construction of the more difficult or unconventional parts, and the startup of the plant. (auth)

13491 (WASH-1130) UTILITY STAFFING FOR NUCLEAR POWER. (Division of Nuclear Education and Training (AEC), Washington, D. C.). Jul 1969. 73p. Dep. GPO $0.75.

The AEC Utility Orientation Program Task Force undertook activities to encourage and facilitate development by electric utilities of the nuclear understanding, orientation, training and education needed by their in-house management, technical and operating staff. The Task Force examined the present and potential availability and adequacy of a variety of private sources of orientation and training programs, in relation to anticipated personnel needs and supply. It believes there are sufficient resources, provided utility management develops adequate advanced planning for their use. Recommendations with the principal objective of assisting utility management in staffing and training for nuclear power are presented. (35 references) (auth)

13492 N-REACTOR-WPPSS COMPLEX OPERATING PERFORMANCE. Leitz, Emil E. (Douglas United Nuclear, Inc., Richland, Wash.). Nucl. Appl. Technol.; 8: 240-5(Mar 1970).

Significant accomplishments of the N Reactor-WPPSS complex are briefly reviewed. The operating experience described includes electrical generation accomplishments, retubing of the steam generators, achievement of a high power level of 4800 MW(t), demonstration of plutonium-tritium coproduct fuel, and decontamination of portions of the primary system piping. (H.D.R.)

13493 THE 1968 ANNUAL REPORT OF THE ABE SUB-COMMITTEE OF TECHNICAL COMMITTEE, I, SCIENCE AND ENGINEERING OF THE DEUTSCHEN ATOMFORUMS e.V. At. Strom; 15: 193-208(Nov 1969). (In German).

The Annual Report gives a short factual account of the results which were achieved in the year 1968 in the nuclear power installations in operation in the German Federal Republic. It is intended to make available to as many as possible of those interested in the development of nuclear power installations — and in particular to electricity supply undertakings — the experience gained by the ABE Subcommittee. (auth)

13494 MORE POWER WILL CROSS EUROPEAN BORDERS. Baer, F. H. (McGraw-Hill World News, Vienna). Power; 112: No. 1, 81(Jan 1968).

A brief review of nuclear power plant development in Eastern Europe is presented. Reactor development programs are described for Bulgaria, Czechoslovakia, East Germany, Hungary, Poland, Romania, and U.S.S.R. (D.C.C.)

13495 VANDELLOS NUCLEAR POWER STATION. Migaud, A. Tech. Mod.; 60: 517-20(Dec 1968). (In French).

This station in Spain is practically identical with Saint-Laurent II in France and contains a graphite-moderated, CO_2 cooled reactor producing 480 MW(e) with fuel replacement under load. The fuel element charge-discharge machine is described in detail. (UKAEA Info. Bull.)

13496 CENTRALIZED RELAY EQUIPMENT OF THE MONTS D'ARREE NUCLEAR POWER STATION. Bobigeat, J.; Cazes, M. REM Aisthom (France); No. 121, 33-43(1968). (In French).

The equipment described, of the modular-type with semiconductors, forms, and computer, comprises the essential part of the automatic control system of the power station. (UKAEA Info. Bull.)

13497 VELOCITY MEASUREMENTS INSIDE THE REACTOR VESSEL OF THE DODEWAARD NUCLEAR POWER PLANT BY CROSS CORRELATION OF THERMOCOUPLE SIGNALS. Termaat, K. P. Ned. Tijdschr. Natuurk.; 36: 6-11(Jan 1970). (In Dutch).

In the downcomer region of the reactor system of the 50 MW(e) Dodewaard Boiling Water Reactor with natural circulation, 30 pairs of fast response thermocouples are used to detect temperature fluctuations in the recirculating reactor water. After amplification and filtering, the signals of each thermocouple pair are fed into a multipoint polarity coincidence correlator to form the cross correlation function. From this function the mean transit time of the temperature fluctuations to cover the mutual distance between the thermocouples is easily found. Then the local velocity is found from a simple relation. The applied method has proven to be very useful in the determination of local fluid velocities from which velocity profiles and total recirculation flow can be derived. 5 references. (auth)

13498 DESIGN PHILOSOPHY OF AUTOCONTROL SYSTEM FOR LATINA POWER STATION. Calcagno, M. (SNAM Div.,

San Donato Milanese, Milan). pp 95-111 of Automation and Instrumentation. /Dadda, Luigi (ed.). Milan; Tamburini Editore (1967).

From 8th International Convention on Automation and Instrumentation, Milan, Italy. See CONF-641138.

The study of the dynamic performance of the most important components for the autocontrol system of the Latina Power Station, is described. In particular the description covers: (a) the preliminary design based on point-models of individual components of control loops (rods and power). These methods allowed an analysis by hand calculations based on frequency diagrams (Nyquist diagrams in this case) of open loop transfer functions and an analysis based on analog computer simulation; and (b) The finalization of the design by means of the analog computer. Since the most important thermal components, i.e., reactor and heat exchangers, are distributed parameter systems, they were represented in a more approximated way than in case (a). The most interesting results obtained are shown on diagrams. (auth)

13499 DATA LOGGING AND COMPUTING EQUIPMENT FOR THE ENRICO FERMI NUCLEAR POWER PLANT. Selmeczy, J. G.; Campiani, A. (Westinghouse Electric Co., Pittsburg. Societe Elettronucleare, Milan). pp 342-54 of Automation and Instrumentation. /Dadda, Luigi (ed.). Milan; Tamburini Editore (1967).

From 8th International Convention on Automation and Instrumentation, Milan, Italy. See CONF-641138.

A Westinghouse PRODAC 510 digital computer system has been installed at the Enrico Fermi Nuclear Power Plant at Trino Vercellese, Italy. The power station includes one Westinghouse pressurized water reactor (primary system) and two Italian-made turbine generator units (secondary system) with total electrical capacity of 300 MW. The computer system utilizes a high speed solid state digital computer specially designed for advanced data logging and process control applications, and is equipped with input-output channels for communication with process peripheral equipment including human-machine communications. The computer for the subject application contains 8,192 (18 bit) words magnetic core memory and 65,536 words auxiliary drum memory. The computer system is connected to the plant through 464 analog inputs, 42 contact closure inputs and 18 process priority interrupt inputs. Its function is to provide monitoring and computations for both the primary and secondary systems of the plant. A major part of the computations is for providing detailed analysis of the reactor core performance. The program for this function is automatically initiated by inputs from the plant instrumentation for the incore flux measurement. It is also anticipated that the computer will calculate the performance of the secondary plant. The program development for this latter function is being developed by SELNI. (auth)

13500 DYNAMIC PERFORMANCE OF THE LATINA POWER STATION. Coxon, T.; Belsey, F. H.; Scott, J. (Nuclear Power Group, Knutsford, Eng.). pp 669-86 of Automation and Instrumentation. /Dadda, Luigi (ed.). Milan; Tamburini Editore (1967).

From 8th International Convention on Automation and Instrumentation, Milan, Italy. See CONF-641138.

Gas-cooled reactor stations are normally considered as supplying base load. Latina Power Station has, however, been specifically designed to give flexible performance over the power range. How the control systems were arranged to achieve this and how they perform in practice are described. The overall performance including that of the power plant, power, and temperature control is given. Overall reactor station power control systems for a gas-cooled reactor station relating the operational performance to design theory are discussed. The field of instrumentation is highlighted in the design and operational stages. Conclusions relevant to a reactor station design and performance are interpreted for contemporary operation and future design implementation. In particular, this interpretation is shown to depend entirely upon instrumentation technique and facilities. (auth)

13501 MEDIUM SIZED (200-450 MW) NUCLEAR POWER STATIONS. Proceedings of a Symposium held at The Queen's University of Belfast, October 2-4, 1968. Belfast; The Queen's University of Belfast [1969]. 270p. (CONF-681075).

The eleven papers presented, for which separate abstracts are given, provide a short account of the technology of various nuclear systems which would be suitable for medium-sized nuclear power stations. Related aspects such as safety and siting, planning and programming, and fuel services are also covered. (UK)

For abstracts of individual papers see: 13502-13507, 13527-13530, and 13552.

13502 REVIEW OF POWER SUPPLIES LEADING TO CONSIDERATION OF NUCLEAR POWER STATIONS FOR THE REPUBLIC OF IRELAND AND NORTHERN IRELAND. Kelly, J. J. (Electricity Supply Board, Dublin); McIlwaine, J. pp 1.1-1.11 of Proceedings of Symposium on Medium Sized (200-450 MW) Nuclear Power Stations, Belfast, October 2-4, 1968. Belfast; The Queen's University of Belfast [1969].

See CONF-681075.

The development of the two electricity systems, North and South, and the factors which have brought these developments about are reviewed. An outline is given of future trends with special reference to the outlook for nuclear power in the respective systems. (UK)

13503 THE LIGHT-WATER PLANTS OF SWITZERLAND: PROBLEMS AND EXPERIENCE. Bertschmann, A.; Weehuizer, F. (Brown Boveri Ltd., Baden, Switzerland). pp 4.1-4.24 of Proceedings of Symposium on Medium Sized (200-450 MW) Nuclear Power Stations, Belfast, October 2-4, 1968. Belfast; The Queen's University of Belfast [1969].

See CONF-681075.

Reasons for this preference for nuclear stations in Switzerland are summarized. Turbosets for nuclear power stations and special problems in turbine design for light water reactors are discussed. Particular attention is given to problems of control. Safety features and licensing procedure are described. (UK)

13504 A SUMMARY OF REACTOR SAFETY EVALUATION AND SITING POLICY IN THE U. K., 1968. Charlesworth, F. R. (Ministry of Power, London). pp 6.1-6.20 of Proceedings of Symposium on Medium Sized (200-450 MW) Nuclear Power Stations, Belfast, October 2-4, 1968. Belfast; The Queen's University of Belfast [1969].

See CONF-681075.

The general principles on which reactor safety in the United Kingdom is based are summarized. Criteria for site evaluation are described. The philosophy behind the policy for ensuring safety in reactor design and operation is outlined. Licensing requirements and the work of the Nuclear Inspectorate are discussed in detail. The protection of operators and persons living near nuclear installations is considered. (UK)

13505 PLANNING AND PROGRAMMING LEADING TO THE COMMISSIONING OF A NUCLEAR POWER STATION. Love, B. (South of Scotland Electricity Board, Hunterston, Scotland). pp 7.1-7.19 of Proceedings of Symposium on Medium Sized (200-450 MW) Nuclear Power Stations, Belfast, October 2-4, 1968. Belfast; The Queen's University of Belfast [1969].

See CONF-681075.

The organization behind the commissioning of the Hunterston Nuclear Station is reviewed. Precommissioning and reactor commissioning phases are described. (UK)

13506 PUBLIC RELATION ASPECTS OF STATION PLANNING, OPERATIONS EXPERIENCE, AND OPERATING REQUIREMENTS. Mears, G. A. (South of Scotland Electricity Board, Hunterston, Scotland). pp 9.1-9.7 of Proceedings of Symposium on Medium Sized (200-450 MW) Nuclear Power Stations, Belfast, October 2-4, 1968. Belfast; The Queen's University of Belfast [1969].

See CONF-681075.

The importance of co-operation with Local Authorities in siting and construction of a nuclear station is emphasized. Other matters discussed include the possibility of reactor trips, refueling, control systems, electrical auxiliary systems, and maintenance. Figures for Hunterston illustrate the high load factors and availability achieved by the Magnox stations. Reference is made to experience in radiation hazards, waste disposal, and transport of irradiated fuel. (UK)

13507 ECONOMICS AND GROUND RULES. Carruthers, H. M. (Central Electricity Generating Board, London). pp 10.1-10.15 of Proceedings of Symposium on Medium Sized (200-450 MW) Nuclear Power Stations, Belfast, October 2-4, 1968. Belfast; The Queen's University of Belfast [1969].

See CONF-681075.

The major factors involved in nuclear economics calculations are interest rate, economic life, and load factor. These are discussed and explanations are given of how they are used by the C.E.G.B. in investment appraisals. (UK)

13508 SHIELDING MEASUREMENTS IN THE RHEINSBERG NUCLEAR POWER PLANT. Gerullis, W. (VEB Kernkraftwerksbau, Berlin); Michaelis, U. E.; Mertins, J. Kernenergie: 12: 328-40(Oct 1969). (In German).

The mean dose rate equivalent in the operational rooms of the

Rheinsberg Power Reactor is less than 6 per cent of the permissible value of 1.25 mrem/h. Maximum values close to homogeneous shields are one tenth up to one fifth of the provided value of 1.25 mrem/h, and the dose rate near irregularities was found to be about 0.1 to 6 mR/h. The actual safety reserves may be reduced by improved or advanced principles of layout, more precise calculations of the source strengths, finer techniques of shield thickness calculations, and optimally chosen compositions of concretes and technologies of concreting. Other savings are possible if local dose rate overshooting is allowed near irregularities. Unfortunately, there are no coherent conceptions of the permissible dose rate overshoots even in international framework. 18 references. (auth)

13509 RECENT TECHNOLOGICAL DEVELOPMENT IN BWR-TYPE LIGHT-WATER REACTORS. Tachibana, Akira (Japan Atomic Power Co., Tokyo). Denki Hyoron; 54: 1137-42(Sep 1969). (In Japanese).

Technological developments in recent years in BWR-type light-water reactors are described. The developments for this period, i.e., from the first BWR power station in Dresden completed in 1960 to the first power station of GE's 1965 type line production in Oyster Creek, are reviewed. Developments subsequent to the BWR in Oyster Creek are described. (NSA of Japan)

13510 THE BN-350 REACTOR. Mitchell III, Walter (Southern Nuclear Engineering, Inc., Dunedin, Fla.). Reactor Fuel-Process. Technol.; 12: 323-34(Fall 1969).

Design parameters of the BN-350 Reactor are presented. Reactor systems and components described include: reactor vessel; core and blanket; control and safety; fuel handling; primary circuit; intermediate circuit; and water–steam circuit. 27 references. (D.C.C.)

13511 THE DESIGN BASIS FOR NUCLEAR POWER-PLANT PROTECTION SYSTEMS. Stone, R. S. Nucl. Safety; 11: 20-4 (Jan-Feb 1970).

The design basis for a nuclear plant protection system gives functional requirements and establishes the circumstances under which the system must be capable of operating. It takes into account both the system's characteristics and those of the entire complex of protective features. These latter characteristics consist in those aspects of plant design that forestall, abort, or mitigate hazardous occurrences in the power-generating chain. The basic requirements are to ensure public safety and, if possible, to prevent damage to the plant. A proper design basis ties together all the information necessary for the development of a competent plant protection system. Without such a design basis, the system will be haphazard and incomplete. (auth)

13512 KANUPP: KARACHI NUCLEAR POWER PLANT. Karachi, Pakistan; Pakistan Atomic Energy Commission (1969). 15p.

The basic design, operating, and economic parameters of KANUPP are presented. The construction schedule is diagrammed. (H.D.R.)

13513 WATER LEVEL INDICATION IN MODERN POWER PLANTS, NUCLEAR AND FOSSIL FUELED. Williams, James W. Combustion; 41: No. 2, 6-14(Aug 1969).

Remote water level indicators of the manometric type are extensively used to monitor the level of the fluid in pressure vessels of modern steam power plants. Three principal applications are discussed: steam drums in a fossil fueled steam generator, reactor pressure vessels in nuclear plants, and feedwater heaters in both. (auth)

13514 THE NUCLEAR POWER STATION OF SAINT-LAURENT-DES-EAUX. DESCRIPTION, CONSTRUCTION COMPLETION, AND STARTUP OF SL-1. Marchal, Jean-Pierre; Gery, Alain; de Gonzague Babinet, Louis. Atompraxis; 15: 406-12(Nov-Dec 1969). (In French).

Summarized are the main features of the first section of Saint-Laurent I, which is the prototype of the second generation of the natural uranium-graphite reactor series; the second section of this series comprises Saint-Laurent II and the nuclear power station of Vandellos (Spain). The objectives of SL I and its gradual realization (time schedules, estimates), and the arrangements made for the proper functioning of the plant are described. The first operating months of the new plant, the conditions under which it was set into operation, the experiences made in productivity tests, and the first power gain are discussed. (auth)

13515 OUTLOOK FOR ENERGY IN THE UNITED STATES. Winger, John G.; Emerson, John D.; Gunning, Gerald D. New York; Chase Manhattan Bank, N.A. (1969). 60p.

Energy demands in the U. S. during 1965 to 1980 are described. Regional requirements for energy are compared with possible energy resources. Trends in energy resource utilization are predicted. (D.C.C.)

13516 SOME TECHNICAL AND POLITICO-LEGAL IMPLICATIONS OF STATIONARY UNDERSEA REACTOR SYSTEMS. Roberts, John J.; Croke, Edward J.; Rose, Leonard. Argonne Nat. Lab. Rev.; 5: 109-15(Oct 1969).

Standards required for undersea reactor systems are reviewed. Hazards involved with undersea sitings are discussed. 21 references. (D.C.C.)

13517 THERMAL POLLUTION. Cole, LaMont C. (Cornell Univ., Ithaca, N. Y.). Bioscience; 19: 989-92(Nov 1969).

Calculations make it clear that man is on a disastrous course if he tries to keep energy production growing by means that will impose an increased thermal stress on the earth. The fossil fuels, and probably uranium and thorium reserves also, would be exhausted before these drastic effects could be attained. The possibility exists, however, that a controlled fusion reaction will be achieved and bring these disastrous effects within the realm of possibility. How we can avoid the consequences of the trends we are following is discussed. It would be necessary to determine what level of human population the earth can support at a desirable standard of living without undergoing deterioration and then to move to achieve this steady state condition. (BBB)

Power Reactor Development

Refer also to abstract 12357.

13518 (AECL–3029) POROSITY FLUCTUATIONS IN LIQUID FLUIDIZED BEDS OF SPHERES. MacFarlane, R.; Armstrong, R. K.; Trupp, A. C. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Jun 1968. 144p. Dep. CFSTI (U. S. Sales Only). AECL $3.00.

The experimental investigation was carried out to provide data for assessing the technical feasibility of a liquid-fluidized bed nuclear reactor. The equipment and techniques for measuring and analyzing local porosity fluctuations are described in detail. Experiments were conducted using water at room temperature to fluidize spheres (diameters 1.2-7.9 mm; densities 2.5-11.3 g/cm^3) in columns up to 44 cm diameter. The influence of measurement zone size, particle diameter and density, and average bed porosity on the magnitude of the root-mean-square porosity fluctuation was isolated by suitable control of the variables. A theory for porosity fluctuations (based on fluidized particle velocity effect and solids concentration) is developed and explains the occurrence of a maximum in the rms porosity fluctuation at a bed porosity of about 70%. Experimental data are also presented on solids motion and on parvoids. (30 references) (auth)

13519 (AI-AEC–12884) LMFBR PHYSICS PROGRAMS. Quarterly Technical Progress Report, July–September 1969. (Atomics International, Canoga Park, Calif.). 15 Nov 1969. Contract AT(04-3)-701. 27p. Dep. CFSTI.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

CRITICAL ASSEMBLIES—physics measurements for sodium voided LMFBR test region of ECEL
—physics measurements for Assembly 48 of ZPR-3, Monte Carlo method for
LIQUID METAL FAST BREEDER REACTOR—physics measurements during July to September 1969
MONTE CARLO METHOD—use in fast reactor physics analysis
REACTORS, FAST—physics measurements for, use of Monte Carlo method for
URANIUM ISOTOPES U-235—neutron cross sections for .015 15 MeV, comparison of methods for (D.C.C.)

13520 (ANL–7640) REACTOR DEVELOPMENT PROGRAM. Progress Report, November 1969. (Argonne National Lab., Ill.). 31 Dec 1969. Contract W-31-109-eng-38. 141p. Dep. CFSTI.

Highlights of project activities are summarized for the month of November 1969. LMFBR physics and component development and Na coolant technology are reviewed. Operations and analysis of the ZPR-3, ZPR-6, ZPR-9, and ZPPR are described. The status of EBR-II research and development and irradiation testing projects is summarized. Reactor fuels, materials development, and nuclear safety studies, including TREAT operations, are described. (H.D.R.)

13521 (APDA-242) QUARTERLY TECHNICAL PROGRESS REPORT ON AEC-SPONSORED ACTIVITIES, APRIL-JUNE 1969. (Atomic Power Development Associates, Inc., Detroit, Mich.). Contract AT(11-1)-865. 117p. Dep. CFSTI.

BOILERS—tube wastage in LMFBR, effects of water leaks on chromium-molybdenum-steel
CHROMIUM ALLOYS AND SYSTEMS—Cr-Mo-steel, wastage of tube of, effects of LMFBR boiler leaks on
CORROSION LOOPS—test program for effects of water leaks on wastage of LMFBR boiler tubes
HEAT TRANSFER SYSTEMS—instrumentation for LMFBR liquid sodium, development of
LIQUID METAL FAST BREEDER REACTOR—boilers for, effects of water leaks on wastage of chromium-molybdenum-steel tubes for
—cooling system of, development of instrumentation for,
MOLYBDENUM ALLOYS AND SYSTEMS—Cr-Mo-steel, wastage of tube of, effects of LMFBR boiler leaks on
RHOMETERS—development of LMFBR liquid sodium
SODIUM—purification processes for liquid, development of LMFBR
STEEL—Cr-Mo-steel, wastage of tube of, effects of LMFBR boiler leaks on
TUBES—wastage of chromium-molybdenum-steel, effects of LMFBR boiler leaks on (D.C.C.)

13522 (CISE-R-154) ORIENTATIVE STUDY OF REACTOR MODERATED BY HEAVY WATER AND COOLED BY A MIXTURE OF STEAM AND WATER. Topical Report No. 20. Casagrande, I. (Centro Informazioni Studi Esperienze, Milan (Italy)). Aug 1965. 50p. (In Italian). Dep. CFSTI (U. S. Sales Only).

A review of the design studies is presented. Two different versions have been studied, concerning the utilization of U metal and of UO_2 respectively. In the first case the fuel element is constituted by a tube cooled on the inner surface, where the cladding acts also as a pressure tube. In the second case the fuel element is constituted by a single cylindrical rod. The studies essentially consist in calculating the fuel elements and the power channel with respect to the thermal, hydrodynamic and mechanical problems. Particular attention is devoted to safety against the thermal crisis of the coolant. Neutronic data have also been calculated. (9 references) (auth)

13523 (IRI-131-69-1) LIQUID METAL FAST BREEDER REACTOR DEVELOPMENT IN THE UNITED STATES OF AMERICA (WITH AN EMPHASIS ON THE INDUSTRIAL APPROACH). Kleijn, H. R. (Interuniversitair Reactor Instituut, Delft (Netherlands)). 31 Jul 1969. 102p. Dep. CFSTI (U. S. Sales Only).

Activities of the General Electric Company and other US fast reactor designers in regard to problems encountered in the development of Liquid Metal Fast Breeder Reactors are described. After an introduction dealing with a general status outlook on fast reactors, the organization of the General Electric Company and the program of its Breeder Reactor Development Operation, aspects of system design, physics and component development are discussed. Further, comments are given in regard to the feasibility of fast reactors as well as to the expected safety performance. Finally, it is concluded that: (1) Commercially competitive fast reactors will probably require an additional 15 years of development work specifically in the areas of materials (including fuel) and instrumentation. The results in due time obtained from demonstration plant reactors will, to a large extent, determine the trend of developments after 1975. (2) Successful development and subsequent design and construction of a fast reactor can be performed only by a group that has an optimum number of highly qualified personnel, where the optimum depends on the scope of work (how much development work is done by others). The success of the project, however, depends as much on proper management as on technical skills. (3) Manufacturers of fast reactor components should not underestimate problems associated with fulfilling design and fabrication specifications and apply the utmost in quality control. (4) All parties that are likely to get involved in the design, manufacturing operation, licensing and financing of fast reactors should prepare themselves adequately and well in advance. In many aspects, a fast reactor is quite different from a thermal reactor. (5) Nuclear engineering departments of universities may contribute in the advancement of fast reactors in areas like physics, instrumentation and control theory, materials research, and engineering. (46 references) (auth)

13524 (ORNL-tr-2244) PROGRESS REPORT ON RESEARCH PROJECTS SPONSORED BY THE FEDERAL MINISTRY OF SCIENTIFIC RESEARCH AND APPLICABLE TO THE REACTOR SAFETY ASPECT. Tietze, A. (comp.) (Technischer Ueberwachungs-Verein e. V., Cologne (West Germany). Institut fuer Reaktorsicherheit). Translated for Oak Ridge National Lab., Tenn., from report IRS-F-2, 51p, Dep. CFSTI.

ACOUSTIC EMISSION TESTING—methods for pressure vessel crack propagation detection
MATERIALS TESTING, NONDESTRUCTIVE—methods for reactor component fatigue analysis
—instrumentation for large multilayer steel failure
PRESSURE VESSELS—failure testing of large multilayer steel, instrumentation for
REACTOR CONTAINMENT STRUCTURES—pressure loss in boiling, effects of sudden
—leak rates in, methods for measurement of
REACTOR FUEL ELEMENTS—cladding of, internal pressure testing of cylinder shaped
—assemblies of 4 and 9 rod, measurement of burnout during stationary and transient operation of
REACTORS, BOILING—stability of power, Nyquist criteria for
—hydrodynamics of power, stability analysis for
—containment for, effects of sudden pressure loss on
REACTORS, POWER—stability of boiling, Nyquist criteria for
—hydrodynamics of boiling, stability analysis for (D.C.C.)

13525 (RCN-111) FAST REACTOR PROGRAMME. First Quarter 1969 Progress Report. Hoekstra, E. K. (comp.) (Reactor Centrum Nederland, Petten). Sep 1969. 85p. Dep. CFSTI (U. S. Sales Only).

Progress of the fast reactor development work carried out at RCN during the first quarter of 1969 is described. The program comprises reactor physics, fuel performance, radiation damage in canning materials, corrosion behavior in canning materials, aerosol research and heat transfer and hydraulics. (auth)

13526 (WASH-1086) EVALUATION OF A HEAVY-WATER-MODERATED BOILING-LIGHT-WATER-COOLED REACTOR. (Oak Ridge National Lab., Tenn.). Dec 1969. 263p. GPO $2.00.

The technology and economics of a direct-cycle 1000 MW(e) heavy-water-moderated boiling-light-water cooled reactor are evaluated. The reactor is natural-UO_2 fueled with a vertical-pressure-tube type core. The boiling-light water and the 19-rod fuel bundles are inside the pressure tubes, and the D_2O moderator is contained in a low-pressure calandria-type vessel. The design provides for on-line refueling at full power. A summary of capital and operating costs indicates the concept to be competitive with other heavy-water-moderated reactor types. Detailed data are included on: (1) concept design; (2) ground rules and cost bases; (3) thermal-hydraulic analyses; (4) physics analyses; (5) control system; (6) reactor safeguards; (7) fuel element performance; (8) core structure; and (9) cost analysis. (H.D.R.)

13527 ENGINEERING AND PERFORMANCE OF GAS-COOLED REACTORS. Lowthian, C. S. (The Nuclear Power Group, Knutsford, Eng.). pp 2.1-2.19 of Proceedings of Symposium on Medium Sized (200-450 MW) Nuclear Power Stations, Belfast, October 2-4, 1968. Belfast; The Queen's University of Belfast [1969].

See CONF-681075.

Development in design principles for Magnox reactors is reviewed and operating experience is described. New features of design introduced into the commercial AGR reactors are also described, and an outline is given of the technology of the HTR. Progressive improvements in reactor parameters and generating costs are illustrated. (UK)

13528 ENGINEERING AND PERFORMANCE OF PRESSURIZED WATER REACTORS. Altvater, W. (Siemens AG, Erlangen, Ger.). pp 3.1-3.23 of Proceedings of Symposium on Medium Sized (200-450 MW) Nuclear Power Stations, Belfast, October 2-4, 1968. Belfast; The Queen's University of Belfast [1969].

See CONF-681075.

The advantages of the PWR concept are summarized. The technology of a light water reactor is compared with that of a heavy water pressure vessel type, and main parameters of each type are tabulated for a medium size station. Illustrated references are made to Atucha, Obrigheim, Stade, and MZFR stations. (UK)

13529 ENGINEERING AND PERFORMANCE OF STEAM GENERATING HEAVY WATER REACTORS. Moore, J. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 5.1-5.23 of Proceedings of Symposium on Medium Sized (200-450 MW) Nuclear Power Stations, Belfast, October 2-4, 1968. Belfast; The Queen's University of Belfast [1969].

See CONF-681075.

The main design features of the SGHWR are reviewed. Technical features affecting plant optimization, operating experience, and engineering of commercial designs are discussed. (UK)

13530 FORWARD DEVELOPMENTS IN NUCLEAR POWER FOR ELECTRICITY GENERATION. Bainbridge, G. R. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 11.1-11.26 of Proceedings of Symposium on Medium Sized (200-450 MW) Nuclear Power Stations, Belfast, October 2-4, 1968. Belfast, The Queen's University of Belfast [1969].
See CONF-681075.

A brief survey is presented of the revised nuclear generating capacity and the objectives of nuclear installations in the Western World during 1970-85. The present status of the different types of thermal and fast reactors is reviewed, and their future economic and technical prospects are compared. It is concluded that commercial fast breeder stations should complement existing and modified types of thermal reactors during 1980-90. Advanced types of fast reactors will only compete toward the end of the century. (UK)

13531 REACTOR AND FUEL-PROCESSING TECHNOLOGY. VOLUME 12, NUMBER 4. One of Four Technical Progress Reviews Published for the Division of Technical Information, USAEC. Washington, D. C.; Atomic Energy Commission (Fall 1969). 47p. GPO $0.75.

Separate abstracts are included for each of the 5 articles presented. Topics discussed include: seismic analysis of primary piping systems; insurance aspects of irradiated fuel shipments; the BN-350 Reactor; current status of liquid Na-cooled reactors; and economics of Pu recycle in thermal reactors. (D.C.C.)

For abstracts of individual papers see: 13510, 13545, 13554, 13558, and 13578.

13532 PRELIMINARY DESIGN OF PROTOTYPE FAST BREEDER REACTOR. Nakajima, Tsutomu (Fuji Electric Co., Tokyo). Fuji Jiho; 42: 794-9(Sep 1969). (In Japanese).

The prototype is to produce 300 MW(e); fuel is mixed PuO_2 and UO_2, and coolant is liquid Na. Construction is scheduled to start in 1973. The purpose is to obtain information for construction of the practical reactor with 1000 MW(e) about 20 years hence. Features of the preliminary design are three loops of coolant, installation of Na pumps on the higher-temperature side, use of a single rotary plug and a rotary arm in fuel exchange, and a divided type of steam generator. The following are described: basic ideas concerning the preliminary design; characteristics of the reactor plant; reactor core, and reactor construction; cooling systems, and main facilities; fuel handling; and safety. (NSA of Japan)

13533 THE GASLINE. Gibrat, R. (SOCIA, Paris). Atompraxis; 15: 412-16(Nov-Dec 1969). (In German).

In order to place the gas cooled reactor within the problem of one or several reactor file programs, the position of the United States which has adopted one reactor file is considered in contrast with the fullness of possibilities of the European gasline. The historical development of the gasline has taken place in seven stages, going out from five characteristics: fast or thermal neutrons, gas or steam turbines, helium or carbonic gas, more or less enriched fuel, coated particles, needles or canned rods. The seven stages are: Magnox or Mark 1, Advanced Gas Cooled Reactor (AGR) or Mark 2, A2GR or Mark 3 (deducted from the AGR), Steam Turbine High Temperature Reactor STHTR, Gas Turbine High Temperature Reactor GTHTR (associating a gas turbine to a high temperature reactor), Steam Turbine Gas Cooled Fast Reactor STGCFR, Gas Turbine Gas Cooled Fast Reactor GTGCFR. The partisans of the gas cooled reactor think that the STHTR should gain the market in the following years and the HTR would exist together with the LMFR which would enter into competition with the GTGCFR. (auth)

13534 FAST NEUTRON REACTORS. Vendryes, M. G. (CEA, Paris). Atompraxis; 15: 396-402(Nov-Dec 1969). (In German).

The reactor "Rapsodie" represents the masterpiece of the plants produced in France for the study of fast neutron reactors. It will mainly be used as test reactor for the fuel elements of this reactor type, and with a reactor power that will be increased from 24 to 40 MW(t), it will provide excellent test conditions for further investigations of fuel elements of the breeder reactor type. A first prototype of 250 MW(e) for industrial purposes, called Phénix, is presently built in Marcoule. Joint research groups of the CEA and EDF are already engaged in studies of fast breeder reactors of high efficiency (1000 MW(e)), for the favorable experiences made so far give rise to hope that this new series of reactors will be capable of supplying practically the total electric energy of nuclear origin that is required for the next 20 years. (auth)

13535 NUCLEAR REACTOR HEAT SOURCES FOR FUTURE POWER GENERATION. Kaufman, Samuel J.; Bogart, Donald; Miller, John V.; Gluyas, Richard E. (Lewis Research Center, Cleveland). Combustion; 41: No. 1, 6-18(Jul 1969).

Data pertaining to prospects for the continued increase of nuclear energy sources for the generation of electric power are reviewed. The characteristics of the fast-breeder reactor which seems to offer the greatest potential for the power industry are examined. Three general areas of fast-breeder reactors are discussed: (1) the difference between breeder reactors and the power reactors now in use, (2) some of the potential materials problems associated with breeder reactors with major emphasis on the fuel-element materials, and (3) the relative merits of gas and liquid-metal coolants for reactors. 15 references. (auth)

Kinetics and Dynamics

Refer also to abstracts 13540 and 13599.

13536 (BARC-415) INTERCOMPARISON CALCULATIONS OF LARGE FAST POWER REACTORS. Singh, R. Shankar (Bhabha Atomic Research Centre, Bombay (India)). 1969. 9p. Dep. CFSTI (U. S. Sales Only).

Calculations of the important physics parameters like critical mass, breeding ratios, neutron spectra, Doppler coefficients and sodium void effects for some large fast power reactors were made using a 22-group cross section set. The results were compared with those obtained by some other organizations which participated in the intercomparison calculations of the same reactors during the Conference on Safety, Fuels, and Core Design in Large Fast Power Reactors held at Argonne National Laboratory in October 1965. (9 references) (auth)

13537 (CISE-R-167) INVESTIGATION OF THE STABILITY OF CIRENE REACTORS BY A SIMPLIFIED ANALYTICAL MODEL. Topical Report No. 3. Alessandrini, A.; Berruti, A.; Peteriongo, G. (Centro Informazioni Studi Esperienze, Milan (Italy)). Sept 1966. 81p. (In Italian). Dep. CFSTI (U. S. Sales Only).

A simplified analytical model is described, which was set up to study the dynamic behavior of CIRENE type reactors. The model is linearized, and takes into account the predominant power-to-reactivity feedbacks for the reactor coupled to the heat transport system. Stability thresholds have been defined using both the Routh-Hurwitz criterion and the root-locus method. A simple digital computer code was used to check the Routh-Hurwitz conditions. Results obtained are satisfactorily compared with those obtained with a more complete analog model. Parametric results for several metal and oxide-fuelled cores are presented, and the influence of characteristic parameters on stability is discussed. (20 references) (auth)

13538 (GA-9817) FAST REACTOR SPECTRUM MEASUREMENTS. Quarterly Progress Report for the Period Ending October 31, 1969. Young, J. C.; d'Oultremont, P.; Neill, J. M. (Gulf General Atomic, Inc., San Diego, Calif.). 13 Nov 1969. Contract AT(04-3)-167. 37p. Dep. CFSTI.

EXPONENTIAL PILES—neutron spectrum in core and iron reflector of STSF-2, comparison of calculated and measured, (E/T)
—neutron spectrum in STSF-6, comparison of calculated and measured, (E/T)
—neutron spectrum in STSF, comparison of LINAC target spectrum with, (E/T)
NEUTRONS, FAST—spectrum of STSF-2 and STSF-6, comparison of calculated and measured, (E/T)
NEUTRONS, INTERMEDIATE—spectrum of STSF-2 and STSF-6, comparison of calculated and measured, (E/T)
RADIATION DETECTORS, SCINTILLATION—performance of lithium-glass and NE-213, comparison for fast neutron, (E/T)
REACTORS, FAST—neutron spectrum in measurements during August to October 1969, (E/T) (D.C.C.)

Control Systems

Refer also to abstract 12376.

13539 SPECIAL MEASURES TO BE TAKEN WHEN LAYING CABLES IN NUCLEAR POWER STATIONS. Breuker, Heinz (Kraftwerk Union AG, Erlangen, Ger.); Specht, Rolf. At. Strom; 15: 185-9(Oct 1969). (In German).

Some of the problems which arise during cable laying in nuclear power stations differ from the requirements in conventional power stations. An explanation is given of the special measures which

have to be taken in buildings housing nuclear components when cable laying. 2 references. (auth)

Cooling Systems

Refer also to abstracts 11661, 11718, 11862, and 12356.

13540 (AECL-3192) SOME NEUTRON SPECTRUM MEASUREMENTS IN A SIMULATED Pb-Bi COOLED 19-ELEMENT UO_2 BUNDLE. Okazaki, A.; Mehta, S. L. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Nov 1969. 22p. Dep. CFSTI (U. S. Sales Only). AECL $1.00.

The following neutron spectrum parameters were measured in a simulated Pb-Bi cooled 19-element natural UO_2 bundle: (1) Westcott epithermal parameter (r) and neutron temperature (T) by activation of Mn, Lu, In and Au foils, (2) neutron density distribution, (3) fast fission ratio and (4) relative conversion ratio. The bundle consisted of 19 CANDU-type Zircaloy clad UO_2 elements inserted in longitudinal holes in the solid Pb-Bi cylinder. Measurements were also made in a D_2O-cooled bundle. The values of r, T and fast fission ratio were higher and the relative conversion ratio was lower for the Pb-Bi cooled than for the D_2O-cooled bundle. 6 references. (auth)

13541 (APED-5592(Pt.4)) LOW-CYCLE FATIGUE TESTING OF PARTIAL-PENETRATION WELDED REACTOR VESSEL NOZZLE CONNECTIONS. PART IV. EVALUATION OF RESULTS. Higgins, J. P.; Hackney, B. D. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Feb 1968. 47p.

The fourth and final report in a series on low-cycle fatigue testing of welded reactor vessel nozzle connections is presented. The results of a 3-year program of combined load testing on full-scale control rod drive nozzle connections are described and evaluated. 4 references. (auth)

13542 (EURAEC-2128) STUDIES ON CYCLONES FOR STEAM SEPARATION IN BOILING-WATER REACTORS. Quarterly Report No. 12, 13, and 14, October 1, 1968-June 30, 1969. (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main (West Germany). Kernenergieanlagen). 23 Jul 1969. Contract 083-66-1-TEED. 15p. (EUR-4021; AEG-E-323-1353). Dep. CFSTI.

Work performed under United States-Euratom Joint Research and Development Program.

The steam/water test stand is described. The test stand was set up in the AEG nuclear power plant at Groswelzheim. The stand was laid out for 160 atm and 400°C; its central unit is the cylindrical upright pressure vessel with a clear height of 7.4 m and an inside diameter of 1.5 m. The vessel can be separated by a flanged joint in order to hold the test objects. The stationary part of the vessel is followed by a circulating loop with a steam injector, by which the rest of the reactor loop is simulated during cyclone tests. The carry-under measuring is done in the circulating loop. By measurement of the mixing column weight, the mass flow of the unseparated steam can be found relatively easy. In separator tests the system pressure and the water level are regulated in the pressure vessel. The necessary auxiliary plants for carrying out these tests are a BENSON boiler heated with oil, which supplies a maximum 46 t/h of steam under approximately 70 atm and saturation temperature, and a condensation plant for the waste steam, which is run at a pressure of 25 atm. (auth)

13543 (GEAP-10072) REACTOR PRIMARY COOLANT SYSTEM RUPTURE STUDY. Quarterly Progress Report No. 17, April-June 1969. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jul 1969. Contract AT(04-3)-189. 30p. Dep. CFSTI.

CHROMIUM ALLOYS AND SYSTEMS—Cr-Mo-steel, crack growth in plate, effects of stress and temperature on low cycle fatigue
HEAT TRANSFER SYSTEMS—pipes for reactor, low cycle fatigue crack growth in
MOLYBDENUM ALLOYS AND SYSTEMS—Cr-Mo-steel, crack growth in plate, effects of stress and temperature on low cycle fatigue
PIPES—crack growth in metal, calculation of low cycle fatigue —stress analysis in metal, comparison of computer programs for
PLATES—crack growth in chromium-molybdenum-steel, effects of stress and temperature on low cycle fatigue —failure of Type 304 stainless steel, measurement of low cycle fatigue
REACTORS—cooling system of, analysis of low cycle fatigue crack growth in pipes of
STAINLESS STEEL—failure of plate shaped Type 304, measurement of low cycle fatigue
STEEL—Cr-Mo-steel, crack growth in plate, effects of stress and temperature on low cycle fatigue (D.C.C.)

13544 (RD/B/N-1512) THE BEHAVIOUR OF RADIOACTIVE ISOTOPES IN LIQUID METAL COOLED FAST REACTORS. PART I. A SURVEY OF THE CHEMICAL PROBLEMS. Evans, H. E.; Watson, W. R. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Dec 1969. 17p. Dep. CFSTI (U. S. Sales Only).

The chemical problems which are relevant to the behavior of radioactive materials in liquid metal cooled fast reactor systems are considered. The behavior of the fission product is considered from its formation in the fuel element. The ultimate fate of the active material which may include plate out or adsorption on constructional material, reaction with hot surfaces, escape to the gas blanket, release to the atmosphere is seen to be strongly dependent on its chemical binding both in the fuel and in the liquid metal. There is not yet sufficient knowledge of the chemical binding of fission products in the fuel element, dissolved in liquid metals, released in coolant fires or of the mechanism of adsorption and deposition processes in liquid metal systems. (auth) (UK)

13545 SEISMIC ANALYSIS OF PRIMARY PIPING SYSTEMS FOR NUCLEAR GENERATING STATIONS. Berkowitz, Lawrence (Franklin Inst. Research Labs., Philadelphia). Reactor Fuel-Process. Technol.; 12: 297-316(Fall 1969).

A description of what is considered to be an adequate seismic analysis of primary piping systems, including major components such as steam generators and primary coolant pumps, is presented. Examples of the approach in analyzing typical, large, complex systems by lumped-mass mathematical model representations are given. Dynamic coupling of the piping system with shielding or containment structure is considered. The advantages and disadvantages of response-spectra, time-dependent, and spectral-density inputs are discussed. A step-by-step procedure for determining the seismic response to response-spectra inputs is summarized. The theoretical basis for computing the response to translatory as well as rocking motion of the base is given. Computer results for response-spectra input are included. 14 references. (auth)

Fuels

Refer also to abstract 12453.

13546 (ANL-7571) A STUDY OF THE PHYSICAL PROPERTIES OF NOMINAL 0.7, 3, AND 6 a/o BURNUP UO_2 FAST-REACTOR FUEL PINS PREPARATORY TO TRANSIENT TREAT EXPOSURE. Stewart, R. R.; Dickerman, C. E.; Stalica, N. R.; Doe, W. B. (Argonne National Lab., Ill.). May 1969. Contract W-31-109-eng-38. 68p. Dep. CFSTI.

The physical condition of 0.7, 3.0, and 6.0 a/o burnup UO_2 fast-reactor fuel pins is documented by numerous charts, tables, neutron and x-ray radiographs, photographs, photomicrographs, and $\beta-\gamma$ and α radiographs. Solid and gaseous fission products are generated during steady-state irradiation of UO_2. Some of these fission products are retained within the UO_2 matrix, causing changes in the physicochemical composition and dimensional stability of the fuel. These effects are discussed. Five fuel pins were used for destructive examination, as many as 18 separate samples being examined from one pin. These five pins were representative of the 0.7, 3.0, and 6.0 a/o burnup groups, which had been irradiated at an initial power density of 2.5 kW/cm^3, corresponding to initial fuel centerline and fuel surface temperatures of 2400 and 1215°C, respectively. Extensive studies were made on several pin cross sections from each burnup group using an electron-microprobe analyzer. As a result of these studies, the microstructural appearance of the fuel was brought into full focus. An especially interesting phenomenon was the occurrence of metallic inclusions, which were found predominantly within large porous regions at the fuel periphery and contained the transition metal fission products Mo, Ru, Tc, Rh, and Pd. The studies of this phenomenon along with the studies of fission-product concentrations and distributions are presented and discussed. 29 references. (auth)

13547 (BNWL-1247) BIPPY: A COMPUTER CODE FOR THE CORRELATION OF FUEL ELEMENT BURNUP AND CLADDING DAMAGE. Dahl, R. E. Jr.; Bourquin, R. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec 1969. Contract AT(45-1)-1830. 28p. Dep. CFSTI.

The method and equations used in the computer code BIPPY are

presented so that results obtained using this method can be evaluated. This code is used to calculate at incremental burnup levels: concentrations of fissile, fertile, and any ten fission product isotopes; lineal heat generation and power density in the fuel pin; heavy element depletion; total neutron fluence; fluence of neutrons with energies greater than 0.1 MeV; cladding damage according to five models; and specific power. Input includes the beginning fuel composition, fuel pin dimensions, neutron flux, and the neutron spectrum. The code is intended for analysis of fast reactor fuel irradiations. No self shielding is considered. 7 references. (auth)

13548 (CISE-R-177) ANALYTICAL STUDY OF HEAT TRANSFER ACROSS THE GAP IN COMPLEX SHAPES. APPLICATION TO CALCULATION OF THERMAL LOSSES TOWARD THE MODERATOR IN A METALLIC-URANIUM REACTOR OF CIRENE-TYPE. Topical Report No. 14. Mazzotti, G.; Lombardi, C.; Pedrocchi, E. (Centro Informazioni Studi Esperienze, Milan (Italy)). June 1966. 79p. (In Italian). Dep. CFSTI (U. S. Sales Only).

The fuel element assemblies of a CIRENE reactor (fueled with uranium metal) are insulated towards the moderator (heavy water at about 60°C) by a gas filled gap having a geometrical complicated shape. Methods for calculating heat losses through the insulating gap are presented. The conformal mapping method applied to a slightly simplified geometry was used in solving heat conduction. As for the convective heat transfer process, an extrapolation procedure has been developed in order to utilize the literature available data. (8 references) (auth)

13549 (EIR-167) CARBIDE-FUELLED FAST BREEDER REACTOR WITH MOLTEN CHLORIDE AS FUEL BONDING MATERIAL AND CHLORIDE VAPOUR AS COOLANT. Taube, M.; Schumacher, H. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). Oct 1969. 35p. Dep. CFSTI (U. S. Sales Only).

Two methods are proposed for improving the performance of a fast reactor. These are: the use of fused chlorides as bonding and heat transporting material in a three-phase fuel element with PuC-UC or nitride solid fuel material; and the use of aluminum trichloride vapour as coolant for the reactor core and as working fluid in the turbine (800°C, 90 ata). When used in a dual-circuit system (e.g., with nitrogen dioxide in the lower temperature cycle) this increases the net power station efficiency to 60%. This also substantially decreases the size of the turbine and improves the technical and economic characteristics of the power station. 47 references. (auth)

13550 (EURFNR-653) INVESTIGATIONS OF THE NATURAL FREQUENCIES, NORMAL FUNCTIONS, EXPANSION FUNCTIONS, AND DAMPING OF TRANSVERSELY OSCILLATING FUEL RODS IN THE Na-1 STUDY. Appelt, K. D.; Kadlec, J. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Translation of report KFK-923. 45p. Dep. CFSTI.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

Calculations of the eigenfrequencies and associated eigenfunctions of the transverse vibrations of fuel rods for the Na-1 reactor studies are detailed. Effects of spacers and water and air media on the damping factors are analyzed; the calculations were made with the IBM 7094. 11 references. (M.L.S.)

13551 (GA-9811) GAS-COOLED FAST BREEDER REACTOR. Quarterly Progress Report, August 1-October 31, 1969. (Gulf General Atomic, Inc., San Diego, Calif.). 30 Nov 1969. Contract AT(04-3)-167. 48p. Dep. CFSTI.

PLUTONIUM OXIDES PuO_2—PuO_2-UO_2, radiation testing of gas cooled fast breeder fuel elements of
—PuO_2-UO_2, performance of fuel elements of stainless steel clad, effects of fuel and cladding compatibility on
REACTORS, BREEDER—core development for gas cooled, Aug. to Oct. 1969
REACTORS, FAST—core development for gas cooled, Aug. to Oct. 1969
REACTOR FUEL ELEMENTS—performance of stainless steel clad plutonium oxide (PuO_2)-uranium oxide (UO_2), effects of fuel and cladding compatibility on, (E)
—radiation testing of plutonium oxide (PuO_2)-uranium oxide (UO_2), for gas cooled fast breeders
REACTORS, GAS COOLED—core development for fast breeder, Aug. to Oct. 1969
URANIUM OXIDES UO_2—PuO_2-UO_2, radiation testing of gas cooled fast breeder fuel elements of
—PuO_2-UO_2, performance of fuel elements of stainless steel clad, effects of fuel and cladding compatibility on (H.D.R.)

13552 FUEL SERVICES FOR MEDIUM SIZED REACTORS. Spencer, P. H. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 8.1-8.9 of Proceedings of Symposium on Medium Sized (200-450 MW) Nuclear Power Stations, Belfast, October 2-4, 1968. Belfast; The Queen's University of Belfast [1969].

See CONF-681075.

The fuel services of the U.K.A.E.A. are described in terms of the fuel cycle. The stages considered are purification and conversion of uranium ore to hexafluoride, enrichment, conversion to UO_2 and fabrication into fuel, provision of fuel designs, management schemes and guarantees, reprocessing, utilization or sale of recovered plutonium, transportation, and optimization work. (UK)

13553 ESTIMATING AVERAGE NUCLEAR FUEL COSTS. Bader, J. F.; Kitzke, K. J.; Nordman, D. A. Power Eng.; 73: No. 12, 50-3(Dec 1969).

The seven-page form for analyzing the effects on nuclear fuel cost of various changes in fuel design parameters, economic and time period assumptions, and operating modes is described. (D.C.C.)

13554 ECONOMICS OF PLUTONIUM RECYCLE IN THERMAL REACTORS. Raleigh, Henry D. (Div. of Technical Information Extension, Oak Ridge, Tenn.). Reactor Fuel-Process. Technol.; 12: 338-42(Fall 1969).

The possible use of Pu fuels in thermal power reactors is analyzed. Economic factors related to fabrication, storage, supply and demand, and utilization are discussed for a period from 1970 to 1985. 30 references. (D.C.C.)

Auxiliary and Emergency Systems

13555 CONSIDERATIONS REGARDING THE PROBLEM OF EMERGENCY COOLING OF A NUCLEAR REACTOR WITH GAS TURBINE. Huebschmann, Wolfgang (Kernforschungzentrum, Karlsruhe, Ger.). At. Strom; 15: 179-82(Oct 1969). (In German).

If a high safety degree for emergency cooling for a gas-cooled high temperature reactor is required, the following construction measures may be introduced: a partly integrated construction, a special construction and mountage of the hp-compressor or an auxiliary steam-turbine driven ventilation system. The safety degree guaranteed by the different methods is studied in regards to failure of the compressor, pipe cracks and heat elimination in case of accident. Their advantages and disadvantages with regard to the gas-cooled high temperature reactor are discussed as the requirements for emergency cooling for this reactor type are especially high. Subsequently the importance of the safety degree for thermal reactors is discussed. 7 references. (auth)

13556 RESULTS OF A POSSIBLE FAILURE OF THE MAIN CIRCULATING PUMPS IN PRESSURE WATER REACTORS. Ulrych, Gerhard (Siemens AG, Erlangen, Ger.). At. Strom; 15: 173-8(Oct 1969). (In German).

The simultaneous failure of all the main circulating pumps in pressure water reactors, which is conceivable, implies a heavy load on the core. By providing suitable means for switching over the power supply to the circulating pumps, the simultaneous failure of the pumps can be made an operational breakdown of the first order. After describing the various effects which have to be taken into account in the analysis of the pump failure, a comparison is made with test results obtained when taking the Obrigheim nuclear power station into operation. 3 references. (auth)

Operation and Economics

Refer also to abstract 13621.

13557 IS THERE A MILLS/KWH FALLACY? Houser, Hugh G. (Westinghouse Electric Corp., Pittsburgh). Elec. Light Power (Boston); 47: No. 12, 85-7(Dec 1969).

Economic comparisons for fossil fuel and nuclear fuel power plants are presented. Errors associated with comparisons are discussed. (D.C.C.)

13558 SODIUM-COOLED REACTORS: CURRENT STATUS. Steele, Myrna L. (Div. of Technical Information Extension, Oak Ridge, Tenn.). Reactor Fuel-Process. Technol.; 12: 335-7(Fall 1969).

Events related to the operation of plant systems in the period

February to June 1969 are summarized for EBR-2, Fermi Fast Breeder Reactor, and Rapsodie. 9 references. (auth)

13559 IMPROVING AGR ECONOMICS BY REDUCING INITIAL LOADING. Clarke, A. W.; Freck, D. V. (Central Electricity Generating Board, Berkeley, Eng.). Nucl. Eng. Int.; 15: 43-6 (Jan 1970).

Economic refuelling during the approach to equilibrium maybe obtained by partial loading initially and then filling the vacant channels as the first refuelling operations. The scheme may be combined with burnable poisons or mixed enrichments. A detailed breakdown of costs is given for fully loaded and partially loaded cores for an AGR. Examples of applications are a reduced initial loading scheme for Dungeness "B," with an estimated saving of £1/kW, and the combination of mixed enrichment with reduced initial loading for Hinkley Point "B." (UK)

Safety and Siting

Refer also to abstracts 11705 and 13613.

13560 (AI-AEC-12885) LMFBR SAFETY PROGRAMS. Quarterly Technical Progress Report, July–September 1969. (Atomics International, Canoga Park, Calif.). 15 Nov 1969. Contract AT(04-3)-701. 13p. Dep. CFSTI.

AEROSOLS—production in LMFBR sodium fires, release and transport following
LIQUID METAL FAST BREEDER REACTOR—safety studies for, review of July to September 1969
REACTOR SAFETY—sodium fires in LMFBR, aerosol release and transport following
SODIUM—combustion in LMFBR of liquid, aerosol release and transport following (D.C.C.)

13561 (BNL-14271) A SUMMARY OF RECENT PROGRESS IN AEROSOL RESEARCH AT BROOKHAVEN NATIONAL LABORATORY. Castleman, A. W. Jr. (Brookhaven National Lab., Upton, N. Y.). [1969]. 15p. (CONF-691113-1). Dep. CFSTI.

From Specialist Meeting on the Behavior of Nuclear Aerosols in Closed Systems, Karlsruhe, Germany.

A long range research program is under way at Brookhaven National Laboratory with the primary objective of developing a fundamental understanding of the chemical reactions, mechanisms of release, and transport behavior of the fission products and radioactive aerosols emanating from nuclear materials under conditions likely to be encountered in the event of an LMFBR accident. Recent progress pertaining to the aerosol physics phase of the program is discussed. Work is in progress to provide information on the nature of aerosols composed of PuO_2, UO_2, sodium, and combinations of each. In addition to the experimental work, a large theoretical research effort is under way to provide a basic understanding of aerosol behavior in closed systems. Computer codes are being developed for use in predicting the time dependence of the mass concentration, number concentration, and particle size distribution. These codes are used in data correlation and evaluation as well as for making scale-up calculations to realistic power-reactor accident conditions. 5 references. (auth)

13562 (BNWL-1266) NUCLEAR SAFETY QUARTERLY REPORT, AUGUST–OCTOBER 1969 FOR NUCLEAR SAFETY BRANCH OF USAEC DIVISION OF REACTOR DEVELOPMENT AND TECHNOLOGY. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec 1969. Contract AT(45-1)-1830. 117p. Dep. CFSTI.

ACOUSTIC EMISSION TESTING—use for plate failure detection, development of system for
AEROSOLS—removal from Containment Systems Experiment, effectiveness of internal recirculating air filters for
CALCINATION—spray equipment and procedures development for radioactive waste solution solidification
CONTAINMENT SYSTEMS EXPERIMENT—air cleaning tests in, analysis of internal recirculating
—flowdown tests in, fluid level and pressure transients during, (E/T)
FILTERS—performance of internal recirculating air, in Containment Systems Experiment
GLASS—production of phosphate, for fixation of radioactive wastes
NEUTRONS, FAST—effects on tensile properties of HSST A533 steel
PLATES—crack detection in metal pressure, acoustic emission method for
RADIOACTIVE WASTE—fixation by conversion to phosphate glass, evaluation of test runs for
—calcination of solutions of, development of spray
REACTOR SAFETY—aerosol removal in Containment Systems Experiment, performance of internal recirculating air filters for
—blowdown tests in Containment Systems Experiment, fluid level and pressure transient during,
STEEL—radiation effects on tensile properties of HSST A533, measurement of fast neutron (D.C.C.)

13563 (DOCKET-50018-1) VALLECITOS BOILING WATER REACTOR. Final [Safety Analysis] Report. (General Electric Co., [San Jose, Calif.] Atomic Power Equipment Dept.). 30 Nov 1959. 310p. Dep. CFSTI.

All the pertinent information describing the VBWR, including modifications, is presented. Separate sections present: (1) descriptions of the reactor, the facility, and the site; (2) procedures for reactor operation and fuel testing; (3) plans, procedures, and protective devices relating to operational mistakes, accidents, or equipment failure; (4) an analysis of the maximum credible accident; (5) waste disposal plans; and (6) descriptions of the experimental facilities. (H.D.R.)

13564 (DOCKET-50018-2) [VALLECITOS BOILING WATER REACTOR]. Technical Information and Environmental Factors. (General Electric Co., Schenectady, N. Y. Atomic Power Equipment Dept.). 17 Oct 1955. 28p. (GEAP-69). Dep. CFSTI.

The preliminary plans for construction and operation of the VBWR are described. The descriptions presented include: (1) the reactor facility; (2) the site; (3) proposed routine and nonroutine operational plans; (4) meteorological, hydrological, and seismological data; and (5) engineered safeguards. (H.D.R.)

13565 (DOCKET-50018-3) [VALLECITOS BOILING WATER REACTOR]. [Preliminary Safety Analysis Report], Amendment 7. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). 27 Jun 1957. 125p. Dep. CFSTI.

Supplementary information concerning the VBWR license application is presented. Separate appendices are concerned with: (1) the reactor basic nuclear parameters; (2) core heat transfer; (3) transient response of the reactor; (4) potential accident conditions; (5) design of the missile shield and containment; (6) instrumentation and control systems; (7) operating procedures and administrative controls; and (8) scope of reactor operations. (H.D.R.)

13566 (DOCKET-50018-4) VALLECITOS BOILING WATER REACTOR. Hazards Analysis by Division of Licensing and Regulation. [Preliminary Safety Analysis Report], Amendment 34. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). 1 Jun 1959. 3p. Dep. CFSTI.

A proposal for a testing and evaluation procedure to demonstrate if power oscillations occur in a core loading containing fuel elements with significantly different thermal and nuclear characteristics is evaluated. The hazards evaluation concludes that the procedure is acceptable with minor additions or changes. (H.D.R.)

13567 (DOCKET-50018-14) [VALLECITOS BOILING WATER REACTOR]. [Preliminary Safety Analysis Report], Amendment 14. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). 2 Dec 1957. 21p. Dep. CFSTI.

A request is presented for permission to operate the reactor with not more than a total of 14 rod type elements in the core. The low enrichment fuel rods are described, and their use in the proposed core loading is analyzed. (H.D.R.)

13568 (DOCKET-50018-15) VALLECITOS BOILING WATER REACTOR. [Preliminary Safety Analysis Report], Amendment 40. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). 2 Dec 1959. 2p. Dep. CFSTI.

An amendment to the VBWR license application is presented. The amendment would authorize operation of the reactor only for the purpose of obtaining normal rated pressure and temperature. (H.D.R.)

13569 (DOCKET-50018-16) VALLECITOS BOILING WATER REACTOR. [Preliminary Safety Analysis Report], Amendment 44. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). 6 Oct 1960. 4p. Dep. CFSTI.

A license application amendment is submitted to revise temperature limits for the Superheat Fuel Demonstration Test Loop. (H.D.R.)

13570 (DOCKET-50018-17) VALLECITOS BOILING WATER REACTOR. [Preliminary Safety Analysis Report], Amendment

45. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). 13 Mar 1961. 14p. Dep. CFSTI.

A license application amendment is submitted to authorize that Amendment No. 44 be deleted and to request higher limits on outlet steam and clad temperatures for the Superheat Fuel Demonstration Test Loop. (H.D.R.)

13571 (DOCKET-50018-18) VALLECITOS BOILING WATER REACTOR. [Preliminary Safety Analysis Report], Amendment 47. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). 8 Sep 1961. 3p. Dep. CFSTI.

Additional information is submitted on a request for authorization to install and operate the Expanded Superheat Advance Demonstration Experiment in the VBWR. (H.D.R.)

13572 (DOCKET-50018-19) VALLECITOS BOILING WATER REACTOR. [Preliminary Safety Analysis Report], Amendment 48. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). 5 Apr 1962. 38p. Dep. CFSTI.

A proposal to use the 160 ft stack of the Vallecitos Superheat Reactor to discharge low-level gaseous wastes from the VBWR is presented. The proposed installation is described and applicable stack release limits are requested. (H.D.R.)

13573 (DOCKET-50018-20) VALLECITOS BOILING WATER REACTOR. [Preliminary Safety Analysis Report], Amendment 50. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). 9 May 1963. 15p. Dep. CFSTI.

A request to replace the turbine driver on recirculation pump No. 2 with an electric motor is presented. This motor is similar to the one which drives recirculation pump No. 1. The new driver is described, and an analysis of simultaneous pump failure is presented. (H.D.R.)

13574 (DOCKET-50018-21) VALLECITOS BOILING WATER REACTOR. [Preliminary Safety Analysis Report], Amendment 51. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). 16 Aug 1963. 19p. Dep. CFSTI.

Additional data on loss of flow accidents are presented to support the request for replacement of the No. 2 recirculation pump turbine driver with an electric motor. (H.D.R.)

13575 (EURFNR-656) SIMULATION OF COOLANT EJECTION IN SODIUM-COOLED BREEDER REACTORS WITH WATER EXPERIMENTS. Fette, P. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Translation of report KFK-940. 22p. Dep. CFSTI.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

Results of experiments to simulate coolant ejection from a sodium cooled reactor core are described. The simulation was made with water rather than sodium; the apparatus and experimental setup are described. Effects of overheating, temperature profile, heat flux density and systems pressure are considered. Data are shown graphically. (M.L.S.)

13576 (IA-1190, pp 257-70) NUCLEAR SAFETY AND REACTOR STUDIES. (Israel Atomic Energy Commission, Tel Aviv).

Projects related to nuclear safety conducted in the Israel AEC nuclear research laboratories during 1968 are summarized. Work in this field dealt mainly with studies of the diffusion of aerosols and gases in the environment and with engineered safeguards in nuclear plants. (H.D.R.)

13577 (ORNL-TM-2412(Pt.7)) DESIGN CONSIDERATIONS OF REACTOR CONTAINMENT SPRAY SYSTEMS. PART VII. A METHOD FOR CALCULATING IODINE REMOVAL BY SPRAYS. Parsly, L. F. (Oak Ridge National Lab., Tenn.). Feb 1970. Contract W-7405-eng-26. 22p. Dep. CFSTI.

A method of analyzing the performance of reactor containment building sprays for the removal of elemental iodine is described. The method depends on the analytical solution to the diffusion equation with surface resistance. Computed values of the solution over a sufficient range of parameters to cover all cases likely to be of interest in safety analyses are presented both graphically and in tabular form. A method of selecting the mean droplet diameter to be used in the calculations is described, and the rationale of the choice is discussed. The recommended procedures should yield conservative predictions of spray performance. A sample calculation using the proposed method is presented. This shows that the calculation predicts a 2-min half-life for removing iodine from a typical PWR containment building. About 10% of the total mass transfer resistance is in the liquid. 10 references. (auth)

13578 INSURANCE ASPECTS OF IRRADIATED FUEL SHIPMENTS. Kane, W. F. (Nuclear Associates International Corp., Rockville, Md.). Reactor Fuel-Process. Technol.; 12: 317-22 (Fall 1969).

The evolution of the nuclear insurance pools is reviewed, and the extent to which they now provide domestic and international insurance coverage is described. A discussion of insurance with respect both to some current problem areas and to possible future developments is presented. 8 references. (auth)

13579 NUCLEAR SAFETY. VOLUME 11, NUMBER 1. Cottrell, Wm. B.; Blakely, J. P.; Jordan, W. H.; Savolainen, A. W. One of Four Technical Progress Reviews Published for the Division of Technical Information, USAEC. Oak Ridge, Tenn., Oak Ridge National Laboratory, Jan.-Feb. 1970. 108p. GPO $0.60.

Twelve articles on nuclear safety in reactor operation are presented. Separate abstracts were prepared for 11. A report on the 1969 ANS Conference on reactor operation experience was omitted. (L.C.L.)

For abstracts of individual papers see: 11705, 12038, 12102, 13511, 13580-13584, 13613, and 13641.

13580 LIQUID-METAL FAST BREEDER REACTOR SAFETY PROGRAM. Baker, L. Jr.; Rose, D.; Miller, C. E. Jr. (Argonne National Lab., Ill.). Nucl. Safety; 11: 1-11(Jan-Feb 1970).

The general aim of the Liquid-Metal Fast Breeder Reactor safety program is the improvement of the technological base needed to understand accident situations, to develop safety systems, and to develop standards and codes for safe design, siting, construction, and operation of AEC test facilities and commercial liquid-metal fast breeders. In its scope the program includes studies of the phenomena associated with abnormal operation, potential accidents, and safety systems designed to prevent accidents or to limit their consequences. Emphasis is placed on prevention, early detection, and control of potential accidents. (auth)

13581 ANALYSIS OF PRESSURE PULSES PRODUCED IN A WATER CHANNEL BY RAPID HEATING. Uchida, Hideo (Tokyo Univ.); Yamura, Takashi. Nucl. Safety; 11: 12-19(Jan-Feb 1970).

A basic investigation was made of the powerful pulselike pressure increases that occur in a narrow water channel when the water is being heated rapidly. In the experiments a vertical water column was heated at the bottom, and the top of the water was a free surface. Temperature change rates on the heater surface were varied from 3000 to 25,000°C/sec. The investigation indicated that the pressure changes in a channel undergoing rapid heating exhibit two kinds of patterns; namely, an initial increase to a peak pressure that is influenced by the heating rate and then a series of pressure pulses that can be explained analytically as a dynamics problem similar to that associated with a water hammer. In this second stage the maximum pressure is greater than the peak pressure in the first stage. These pressure changes are similar to pressure changes observed in BORAX and SPERT experiments. (auth)

13582 PROGRESS SUMMARY OF NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROJECTS. Savolainen, A. W.; Whetsel, H. B. (Comps. and eds.). Nucl. Safety; 11: 67-82 (Jan-Feb 1970).

13583 GENERAL ADMINISTRATIVE ACTIVITIES. Blakely, J. P. (Comp.). Nucl. Safety; 11: 83-6(Jan-Feb 1970).

Activities summarized include the establishment of the Atomic Safety and Licensing Appeal Board and considerations of environmental problems in California, in Minnesota, and at the National Governors' conference. (H.D.R.)

13584 ACTION ON REACTOR AND OTHER PROJECTS UNDERGOING REGULATORY REVIEW OR CONSIDERATION. Blakely, J. P. (Comp.). Nucl. Safety; 11: 86-101(Jan-Feb 1970).

13585 THE TECHNICAL DOSIMETRIC INVESTIGATION OF HEAVY WATER HWGCR REACTOR CYCLES ON A REACTOR WATER LOOP. Kopec, Josef (Power Research Inst., Jaslovske Bohunice, Czech.); Zajic, Vladimir. Jad. Energ.; 16: 9-16 (1970). (In Czech).

The problems of dosimetric inspection and radiochemical analysis of heavy water are described. The experimental results attained on the water loop of the WWR-S reactor have been treated concerning the activation of corrosion products. The activity of the corrosion products has been measured in different phases of the reactor operation and the methods of detecting individual radioisotopes have been discussed. 8 references. (auth)

Power Conversion Systems

13586 STUDY OF DYNAMIC BEHAVIOR OF SECONDARY CIRCUIT OF GAS-COOLED ADVANCED REACTOR. Loth, Ralf (Brown, Boveri und Cie AG, Mannheim, Ger.); Offner, Eric. At. Strom; 15: 183-5(Oct 1969). (In German).

Thorough knowledge of the dynamic behavior of a nuclear station, under normal operating conditions as well as in an emergency, is necessary for optimal dimensioning of the control and safety systems. These studies of the dynamic behavior are carried out in general with the help of extensive calculating programs. The simulation of the secondary circuit using a digital calculation program is described. The efficiency of this program is demonstrated by examining a series of fault situations. 2 references. (auth)

Research and Test Reactors

Refer also to abstracts 11826, 12350, 12351, 12392, 12435, 12450, 12452, 13212, 13262, 13520, 13525, 13531, 13538, and 13558.

13587 (ANL-7613) A STUDY OF THE DYNAMIC RESPONSE OF VARIOUS EBR-II CONFIGURATIONS TO HYPOTHETICAL MALFUNCTIONS IN THE REACTOR SYSTEM. EBR-II Project. Campise, A. V. (Argonne National Lab., Ill.). Nov 1969. Contract W-31-109-eng-38. 87p. Dep. CFSTI.

The dynamic response characteristics of various EBR-II irradiation-configuration loadings were investigated by using the space-independent kinetics code AIROS-IIA for dynamic simulation of the reactor system. The basic dynamic model was first used on system malfunctions outlined in the EBR-II Hazards Summary Report and shown to give very good agreement with published data. Subsequent irradiation core loadings were studied under various assumed hypothetical accident conditions to establish the details of the dynamic response of various metallic- and ceramic-fueled subassemblies. Dynamic response differences are noted under conditions of reduced and full coolant flow. Ceramic-fueled subassemblies will tend first to release activity under all transient conditions with full coolant flow. Conversely, metallic-fueled subassemblies will tend first to release activity under loss-of-flow conditions for all the cases studied. (12 references) (auth)

13588 (ANL-7623) SYSTEM FOR MEASURING SODIUM LEVEL IN EBR-II. Waldo, James B.; Christensen, Lynn J. (Argonne National Lab., Ill.). Oct 1969. Contract W-31-109-eng-38. 16p. Dep. CFSTI.

A system for measuring the level of liquid sodium has been designed and fabricated, and has been tested in the EBR-II primary tank. The transmitter of the system consists of a partially submerged buoyancy cylinder hanging from a force transducer. A stainless steel bellows is used as a gas seal. The system, which has a measuring range of 20 in., demonstrated an accuracy of $\pm 1/4$ in. during six months of test operation in the primary tank. It provides readout, and high- and low-level alarms and trips. (auth)

13589 (BARC-399) OPERATING EXPERIENCE OF ZERLINA REACTOR WITH EPOXY COATED MILD STEEL SQUARE BOX. Kumar, Ss. Rakesh; Santanagopalan, S.; Prabhu, L. H.; Shah, G. C.; Vartak, D. G. (Bhabha Atomic Research Centre, Bombay (India)). 1969. 31p. Dep. CFSTI (U. S. Sales Only).

Investigation on the degradation in chemical and isotopic purity of heavy water of Zerlina Reactor, after operating the reactor with a mild steel square box coated with epoxy paint, was carried out. Isotopic degradation of the system heavy water was found to be due to the presence of exchangeable protons in the paint material and deterioration in chemical purity was attributed to the radiation effects on the solvents left over because of insufficient drying of the paint. Proper drying of the painted square box prior to its installation and complete deuterisation of the paint before the reactor startup was proved to be effective in preventing contamination of the system heavy water during reactor operation. Samples of polyvinyl paints were also tested for their suitability in coating the mild steel square box of Zerlina. The vinyl paint, with binding material of polyvinyl tripolymer, was found to be suitable for the square box coat. (auth)

13590 (BAW-3867-9(Vol.4)) FAST BREEDER REACTOR STATIC PHYSICS METHODS DEVELOPMENT AND ANALYSIS PROJECT. VOLUME 4. PRODUCTION TESTS AND SENSITIVITY STUDIES USING THE FARED CODE. Neuhold, R. J. (Babcock and Wilcox Co., Lynchburg, Va. Power Generation Div.). Nov 1969. Contract AT(30-1)-3867. 36p. Dep. CFSTI.

The FARED computer program and associated library have been used to calculate ZPR-3 Assembly 48 and ZPR-3 Assembly 11. The calculated results for k_{eff}, spectral indices, central reactivity worths, Doppler coefficients and fluxes are compared with reported experimental data. Additional calculated data on the two assemblies are provided as B&W's contribution to the CSEWG Phase II, ENDF/B data evaluation. Sensitivity studies using the B&W-1000 MW(e) Follow-On reference design are presented. These studies include: the effect of cross section re-averaging during depletion; the effect of homogeneous versus heterogeneous resonance treatment; the effect of the number of groups and downscatter groups on criticality and depletion; and the effect of buckling values in spectrum generation. 6 references. (auth)

13591 (BNWL-500(Vol.21)) CONCEPTUAL FACILITY DESIGN DESCRIPTION FOR STRUCTURES NO. 21. Fast Flux Test Facility. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 3 Apr 1969. Contract AT(45-1)-1830. 201p. Dep. CFSTI.

The three FFTF concrete and steel Reactor Support Buildings are described. These three major buildings are the Reactor Service Building, the Heat Transport Systems Building, and the Engineering-Operations Building. Detailed data are included on the functions and design requirements, physical description of the facility, safety considerations, principles of operation, and maintenance principles. (H.D.R.)

13592 (BNWL-1172) TAP-LOOP: A STABLE THERMAL ANALYZER CODE FOR THERMAL ANALYSIS OF CLOSED HYDRAULIC SYSTEMS. Leach, C. E.; Kelley, E. L. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan 1970. Contract AT(45-1)-1830. 150p. Dep. CFSTI.

A finite difference digital code for steady-state and transient thermal analysis of recirculating fluid loops, TAP-LOOP, was derived from the original TAP code developed by Atomics International. Stability improvement and transport lag times were incorporated in the TAP code to provide a more useful design tool for thermal analysis of closed hydraulic systems. Theory, logic, program listing, input and test case results are given. (auth)

13593 (BNWL-1235) THERMAL ASPECTS OF THE FFTF REACTOR REFUELING SYSTEM. Lillie, A. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec 1969. Contract AT(45-1)-1830. 75p. Dep. CFSTI.

Thermal analyses of three potential fuel handling schemes for the FTR refueling subsystem are described. The handling schemes considered were (1) indirect gas cooling of driver fuel, (2) indirect gas cooling of closed loop test fuel, and (3) direct gas cooling of closed loop and open test assemblies. The analysis is restricted to normal fuel handling operations involving undamaged fuel. Results are presented in terms of decay heat loads and limiting temperatures for each handling method. 7 references. (auth)

13594 (BNWL-CC-1149) THERMAL HYDRAULICS DEVELOPMENT. Hesson, G. M.; Padilla, A.; Yatabe, J. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 6 Apr 1967. Contract AT(45-1)-1830. 109p. Dep. CFSTI.

A comprehensive plan is presented of the thermal-hydraulics development effort needed to support the core design for the Fast Flux Test Facility. The plan is oriented to meet requirements dictated by a wide range of core performance criteria. The objectives are fourfold in nature: (1) Identify thermal-hydraulic problem areas in the FFTF design; (2) Assess the current status of the technology; (3) Outline the laboratory development program required to solve the thermal-hydraulic problems; and (4) Describe and evaluate the alternate avenues of solution. The scope of this plan is limited to thermal-hydraulic problem areas arising from and directly associated with driver and test fuel in-core operation. 12 references. (auth)

13595 (CONF-671224) HFR INFORMATION MEETING, PETTEN, THE NETHERLANDS, DECEMBER 7th-8th 1967. (European Atomic Energy Community, Petten (Netherlands). Joint Nuclear Research Center). 120p.

Topics described which are related to the High Flux Reactor include: experimental facilities, physics measurements, irradiation programs, instrumented radiation target cans, in-pile loops, and equipment for destructive testing of fuel elements. (D.C.C.)

13596 (DOCKET-50184-17) [NATIONAL BUREAU OF STANDARDS REACTOR]. [Application for Full Term License:] Attachment A. Additional Information Required. (National Bureau of Standards, Washington, D. C.). 15 Jan 1970. 17p. Dep. CFSTI.

Supporting information for the proposed changes in the NBS Re-

search Reactor Technical Specifications is given. Changes to requirements for testing and surveillance frequencies are discussed; justifications for proposed action are given. Axial thermal flux distributions through the center of the highest power element are shown; comparisons of relative average power per element are tabulated for calculated and measured values. Burnout ratio calculations, based on experimental and measured data, are presented. A proposed specification for calibration of the fission product monitors is included. (M.L.S.)

13597 (DOCKET-50184-18) NATIONAL BUREAU OF STANDARDS REACTOR. Report on Suspected Malfunction of Low Outlet Flow Scram. (National Bureau of Standards, Washington, D. C.). 4 Feb 1970. 9p. Dep. CFSTI.

The suspected malfunction of the low-flow outlet scram for the NBS Research Reactor is described. The surveillance and checking to establish the problem areas are discussed. The relay safety system is described. (M.L.S.)

13598 (EIR-165) MEASUREMENT OF THE RELATIVE CONVERSION RATIO IN A D_2O MODERATED LATTICE FUELLED BY NATURAL URANIUM. Richmond, R.; Rueeger, B.; Windiate, A. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). Oct 1969. 40p. Dep. CFSTI (U. S. Sales Only).

Measurements have been made, in the reactor PROTEUS, of the relative conversion ratio in a D_2O-moderated lattice fueled by a gas-cooled cluster of natural uranium metal rods. The lattice was similar to that of the LUCENS experimental power station. The results were compared with the predictions of the U.K. lattice code WIMSD and the discrepancy was found to be consistent with that normally given by this code for D_2O-moderated lattices. 16 references. (auth)

13599 (EURFNR-669) INTERPRETATION OF DOPPLER SAMPLE MEASUREMENTS IN FAST CRITICAL ZERO-ENERGY ASSEMBLIES. Fischer, E. A. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Translation of report KFK-844. 101p. Dep. CFSTI.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

Application of perturbation theory to the analysis of Doppler-sample measurements made in zero-power assemblies is detailed. The multigroup integral transport equation is formulated. The perturbation theory solution to the equations describing the heated sample measurements is derived; the recursion formulae for the iterative evaluation of the integrals are given. Analytical methods used in processing the data from the Doppler samples are discussed; the pertinent equations are formulated. Effects of the heating of the Doppler samples are evaluated. A detailed analysis of the theory of the Doppler coefficient for fast reactors is given. Results of calculations and analyses are shown graphically; these results are compared with ZPR measurements of a similar nature. 35 references. (M.L.S.)

13600 (FMRB-13/69) INVESTIGATIONS ON NEUTRON NOISE IN THE BRAUNSCHWEIG RESEARCH AND TESTING REACTOR (FMRB). Viehl, E. (Physikalisch-Technische Bundesanstalt, Brunswick (West Germany)). Mar 1969. 15p. (In German). Dep. CFSTI (U. S. Sales Only).

An introduction into the theory of reactor noise is given, followed by first measurements of the auto spectral density at the Measuring and Research Reactor (FMRB). The reactor power determined by reactor noise was in good agreement with the value given by the instrumentation, which has been calibrated by nuclear power measurements. The prompt neutron lifetime depends upon the measuring position. Values were found at the edge of the core between about 69 and 74 μs. 9 references. (auth)

13601 (GEAP-10010-22) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR DEVELOPMENT PROGRAM. Quarterly Report No. 22, August-October 1969. Pflasterer, G. R.; Becker, R. A. (comps.) (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Nov 1969. Contract AT(04-3)-540. 50p. Dep. CFSTI.

BERYLLIUM OXIDES—reactivity worth in full size SEFOR core, (E/T)
BORON CARBIDES—reactivity worth in full size SEFOR core, (E/T)
PLUTONIUM OXIDES PuO_2—PuO_2-UO_2, reactivity worth in full size SEFOR core, (E/T)
REACTIVITY—temperature coefficient for full size SEFOR core
—worth measurements on SEFOR core materials, (E/T)
REACTOR FUEL ELEMENTS—fabrication of SEFOR instrumented
—reactivity worth of SEFOR mixed oxide, (E/T)
SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR—fuel assemblies for, fabrication of instrumented
—reactivity temperature coefficient for full size core in, (E/T)
—reflectors for, reactivity worth calibrations on, (E)
—core materials for, reactivity worth of, (E/T)
—reactivity worth measurements in, deviation of single critical position, (E/T)
—startup testing during Aug. to Oct. 1969
—operation during Aug. to Oct. 1969
—maintenance during Aug. to Oct. 1969
STAINLESS STEEL—reactivity worth in full size SEFOR core, (E/T)
URANIUM OXIDES UO_2—reactivity worth of depleted, fuel elements in full size SEFOR core, (E/T)
—PuO_2-UO_2, reactivity worth in full size SEFOR core, (E/T) (H.D.R.)

13602 (GEMP-720) THEORETICAL SPECTRUM-THRESHOLD DETECTOR DATA CORRELATION IN EBR-II. Kamphouse, J. L.; Stuart, R. L.; Moteff, J. (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs). Sep 1969. Contract AT(40-1)-2847. 36p. Dep. CFSTI.

An experimental and computer program to further examine the neutron environment in the Experimental Breeder Reactor-II (EBR-II) has been completed. Monte Carlo and S_4 Transport methods were used to determine the neutron spectrum at various positions in the EBR-II core and blanket regions. Response functions for the threshold detectors $^{58}Ni(n,p)^{58}Co$ and $^{54}Fe(n,p)^{54}Mn$ were determined for each position and the corresponding predicted induced activities are compared with experimental results. Based on combinations of calculated neutron spectra, experimental detector responses, and cross section end points an empirical differential cross section was determined for the $^{46}Ti(n,p)^{46}Sc$ threshold reaction. Spectrum averaged cross sections for the three threshold reactions which have been determined at various positions in this facility suggest that significant errors in fast neutron fluences will result if the usual fission spectrum averaged cross sections are used. 13 references. (auth)

13603 (RISO-M-984) REACTIVITY MEASUREMENTS OF CONTROL AND SAFETY ABSORBERS IN DR 3 BY MEANS OF THE INVERSE KINETICS METHOD. Haack, K. (Danish Atomic Energy Commission, Risoe. Research Establishment). Nov 1969. 25p. Dep. CFSTI (U. S. Sales Only).

The recorder flux trace for the first seconds after insertion of absorber(s) in a steady critical reactor core is used to calculate the reactivity value of the absorbers by means of the FORTRAN code KINIKOO. The code calculates the Inverse Kinetic equations for prompt and multigroup delayed neutrons and multigroup photoneutrons from the deuterium. (auth)

13604 (WARD-3977-1) SURVEILLANCE AND IN-SERVICE INSPECTION RECOMMENDATIONS FOR THE FTR: TECHNIQUES, PROGRAM, DEVELOPMENT. Buggy, J. J.; Dill, D. L.; Paxson, E. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Feb 1969. Contract AT(30-1)-3977. 192p. Dep. CFSTI.

Surveillance and in-service inspection of the FTR reactor internals and reactor system components are recommended to assist in preventing failures that could affect the preservation of public health and safety, and to guard against failures that could have significant effects on plant availability, repair cost, and time. For the reactor internals, the recommended inspections include: Continuous capability for diagnostic monitoring using noise analysis; Frequent in-vessel general visual inspection under sodium using an acoustic viewing system; A materials program consisting of continuous irradiation of specimens in the FTR with periodic ex-reactor testing; Infrequent in-vessel detailed visual inspection under sodium using an acoustic viewing system; and Infrequent, and only as required depending upon reactor operation and other inspection results, in-vessel and ex-vessel dimensional measurements, visual inspection, and non-destructive testing. For the reactor system components, the recommended inspections include: Periodic visual inspection of the reactor vessel exterior and interior surfaces and head, primary piping system hangers and supports, valves, primary sodium pumps, and primary equipment cells; Periodic ultrasonic non-destructive testing of selected welds in the primary piping system, and of the reactor outlet nozzle to shell welds; Continuous vibration monitoring of the primary sodium pumps and valves; Continuous temperature measurement of primary sodium pump bearings; Continuous leak detection of valve seals; and Periodic disassembly of selected valves. These recommendations are

based on the FTR concept applicable at the time of the study. Included is a state-of-the-art survey dealing with inspection experience and techniques, descriptions of recommended inspection equipment and techniques, recommendations pertaining to access for and handling of inspection equipment, and a description of a recommended in-service inspection and surveillance program. Finally, four areas requiring research and development are identified, and recommended programs are given. These are: Diagnostic monitoring using noise analysis for detecting reactor internals malfunction; An acoustic viewing system for viewing and inspecting under sodium; An ultrasonic testing system for inspecting reactor systems components; and Accelerometers for use with reactor systems components in high radiation and high temperature environments. A suggested schedule to produce results in time for the FTR and an approximate program support estimate are given for each program. 214 references. (auth)

13605 (WARD-3977-2) FFTF CONTROL ROD DRIVE MECHANISM CONTINUATION STUDY (TASK 13). Dill, D. L.; Kazan, J. M.; Lain, P. J. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). May 1969. Contract AT(30-1)-3977. 127p. Dep. CFSTI.

A conceptual design is presented for a 4-coil magnetic jack Control Rod Drive Mechanism (CRDM) suitable for locating in the head of the FFTF annular conical core reactor concept. The design presented should be applicable to other reactor concepts with similar requirements. The design presented will: (1) provide increments of 0.150 inch of control rod step motion; (2) provide a maximum speed of rod motion of 0.15 in./sec (9 in./min); (3) provide for 44 inches of rod travel; (4) carry a drive line assembly weight of up to 500 pounds; and (5) provide for a rod insertion time of less than 0.39 second from when the signal reaches a fully withdrawn mechanism till the control rod is completely inserted into the core. This design presents a minimum effective length mechanism, with respect to present state-of-the- art knowledge. The operational environment of this mechanism was sufficiently analyzed in this concept to establish feasibility. The mechanism presented consists of the magnetic jack drive mechanism, an Ar purge system, an Ar cooling system, a gas-accumulator scram system, and a primary rod position-indicating system. A program is outlined for the development work required to make this concept operational. 20 references. (auth)

13606 INTEGRAL, FAST-NEUTRON FLUXES IN THE IRRADIATION FACILITIES OF THE SM-2 REACTOR. Klinov, A. V.; Kormushkin, Yu. P.; Polivanov, I. F.; Frunze, V. V.; Tsykanov, V. A. At. Energ. (USSR); 27: 457-8(Nov 1969). (In Russian).

Studies were carried out for improving the physical characteristics of the SM-2 reactor. The low-threshold $^{115}In(n,n')^{115}In$ reaction was used for recording fast neutrons in all types of irradiation facilities of the reactor; in order to decrease the effect of thermal neutrons on the detectors, the indium foils were encased in 1-mm thick Cd sheets. An NaI(Tl) single-crystal γ spectrometer was used to measure the induced activity. The results, corrected with respect to the nominal power level of the reactor, were tabulated; the highest level, in the core region, reached $1.46 \pm 0.39 \times 10^{15}$ neutrons/cm^2 sec. (TTT)

13607 MEASUREMENT OF RADIAL POWER DISTRIBUTIONS IN A TRIGA FUEL ELEMENT DURING REACTOR POWER EXCURSIONS. Goodwin, W. A.; Wyman, M. E. (Univ. of Illinois, Urbana). Nucl. Appl. Technol.; 8: 246-54(Mar 1970).

The time and space dependent temperature distribution within a TRIGA Mark II fuel element has been measured during a series of power excursions. The temperatures were obtained from fourteen thermocouples welded to the uranium-zirconium hydride fuel at various radial locations. The experimental temperatures were used to solve the radial time-dependent heat conduction equation for the local heat generation rate (power density) as a function of radius and time during each pulse. Within the accuracy of the measurement, the radial power profile was found to be independent of the fuel temperature. 6 references. (auth)

13608 EXPERIMENTAL DETERMINATION OF THE DIFFERENTIAL FAST-NEUTRON FLUX IN THE HIGH FLUX ISOTOPE REACTOR USING THRESHOLD DETECTORS. Dodds, H. L. Jr.; Pasqua, P. F. (Univ. of Tennessee, Knoxville). Nucl. Appl. Technol.; 8: 296-301(Mar 1970).

The differential fast neutron flux above 0.5 MeV at one spatial position in the High Flux Isotope Reactor was determined experimentally using several threshold activation detectors. The series expansion technique utilizing the concept of least squares was used to obtain an approximate solution to the set of integral equations which are defined by the experimentally determined activation data. Good agreement was achieved between the integrated flux (i.e., the differential flux integrated above 0.5 MeV) determined and the integrated flux determined independently using one-dimensional, multigroup diffusion theory. (auth)

13609 POWER INCREASE OF THE ROSSENDORF RESEARCH REACTOR WWR-S FROM 2 TO 10 MW. Adam, E.; Endler, A.; Hieronymus, W.; Klebau, J.; Beatus, H.; Westphal, D.; Wetzel, L. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie; 12: 322-7(Oct 1969). (In German).

Problems of the Rossendorf research reactor power increase from 2 to 10 MW using modified Soviet fuel elements of E-CH 1 type are described. The results obtained with the critical assembly "RAKE" are briefly estimated. The measures of reconstruction which were necessary because of increasing allowed maximum reactor power level and on account of putting in a new fission zone are described. The experiments carried out during restart of the reactor are discussed in detail. The measurements of temperature and safety experiments carried out for this purpose prove that safe operation of the reactor with the provided power of 10 MW is possible. 17 references. (auth)

13610 REPAIR OF RESEARCH REACTOR JRR-2. 1. Keikinzoku Yosetsu; 7: 139-47(Apr 1969). (In Japanese).

The JRR-2 is a research reactor, employing 90%-enriched MTR-type fuel, moderated and cooled by heavy water, with maximum heat output of 10,000 kW; it went critical in February 1960. The repair of deformations in fuel channels, planned originally for the period from November 1968 to March 1969, was carried out earlier for the period from October 1968 to January 1969, because of an accidental fire in the control room. Together with this, the repair for heavy-water leakage at the rings of the reactor support was carried out. The repair of the leakage at the rings is described. Aluminum was employed to seal the rings. The following are described: an outline of JRR-2, the operation of JRR-2, leakage of the heavy water, preliminary repair of the leakage, and leakage after this repair. (NSA of Japan)

13611 REPAIR OF RESEARCH REACTOR JRR-2. 2. Keikinzoku Yosetsu; 7: 217-26(May 1969). (In Japanese).

After the first repair of the leak of heavy water, the leak continued to increase, and from October 1968, extensive repair for the leak of heavy water at the support ring was carried out in parallel with repair of deformation in the lower-plug fuel holes. Because of the difficult condition under intense radiations, prior to the actual repair, the method of seal welding was investigated, and also training of the welders and guidance of the welding were performed. Operation of JRR-2 was started in February 1969, and up to the present, no leaks of heavy water have been observed. The repair of heavy-water leaks in JRR-2 is described on the following: planning for the repair; determination of the welding method, including seal plate form and welding conditions; training of the welders; affirmation of the welding method by mock-up test; and repair of the heavy-water leaks, including removal of the resin, welding for the helium hole and the control-rod hole, welding of the seal ring and plate, in-pile welding, leak test of the welds, and test in the loaded condition at the welds. (NSA of Japan)

13612 G 1 REACTOR. Martin, D. (CEA, Marcoule, France); Vielh, P.; Savineau, M. Energ. Nucl. (Paris); 11: 427-31(Oct 1969). (In French).

A review of Marcoule Reactor's (G-1) operations during 1957 to 1968 is presented. Conditions of the reactor components at final shutdown in 1968 are described. (D.C.C.)

13613 SAFETY-RELATED OCCURRENCES REPORTED IN AUGUST-SEPTEMBER 1969. Casto, W. R. Nucl. Safety; 11: 64-6(Jan-Feb 1970).

Brief summaries of unusual occurrences at reactors and facilities using radioactive materials are presented. The occurrences include contamination in a tritium painting facility, shipment of an unshielded radiation source, calibration problems with BWR instrument channels, and a number of malfunctions associated with control rods of various reactor facilities. (H.D.R.)

13614 NEUTRON DIFFRACTION. Wepner, Wolfgang. Bild Wiss.; 6: 446-55(May 1969). (In German).

The development of reactor technology has established new interest in neutron diffraction as a method for the investigation for the structure of materials, particularly with respect to the crystalline and magnetic structure of metals. Applicable properties of electromagnetic radiation are discussed, and the implications of the Davisson–Germer experiment reviewed. The construction of apparatus for such experiments and the problems of radiation in experiments are discussed; a close description of the instrument at the nuclear research station at Juelich is

given. This unit has a 40 × 40 mm channel operated by 3 rotatable cylinders closed or opened by a shutter from the source to the irradiated object. Focussing and absorption of stray neutrons is controlled to within 0.1°; the principle of the monochromator is outlined. The initial flux is 10^{13} n/cm²sec, but only a fraction of this after monochromatization and other steps, so that a diffraction pattern can be as much as several days in recording. An example of the technique is the analysis of the crystal structure of Fe_3Si, which is explained at length. (BBB)

Rocket and Space Reactors

Refer also to abstract 11892.

13615 (BARC-437) RADIOACTIVITY IN CIRUS PRIMARY COOLANT AND MODERATOR SYSTEMS. Paul, A. C. (Bhabha Atomic Research Centre, Bombay (India)). 1969. 53p. Dep. CFSTI (U. S. Sales Only).

The CIRUS reactor is a natural U fueled, heavy water moderated, light water cooled reactor of the NRX type. Radioactivity levels in the moderator and cooling systems from fission products and activated impurities were measured. Activities of specific nuclides in the systems and radiation fields in various locations in the systems are tabulated. 22 references. (H.D.R.)

13616 (N-69-40060) STEAM CYCLE FOR AIRCRAFT NUCLEAR PROPULSION. Fishback, Lawrence H. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Oct 1969. 21p. (NASA-TM-X-1907). CFSTI.

A preliminary cycle analysis of a steam-driven, nuclear-powered turbofan engine is presented. It is found that maximum efficiency and minimum thrust per unit airflow both occur for a bypass ratio of zero. This corresponds to minimum heat-exchanger-outlet air temperature. Parametric numerical results are presented which can be used for selecting the proper engine operating conditions for a given airplane. (auth) (STAR)

13617 (N-70-10766) INVESTIGATION OF MERCURY-FLOW RAMP RATES FOR STARTUP OF THE SNAP-8 SYSTEM. Lottig, Roy A.; Soeder, Ronald H. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). 26 Sep 1969. 112p. (NASA-TM-X-52689). CFSTI.

A critical parameter in the startup of the SNAP 8 system is the rate at which the Hg flow is brought up to the level required to make the system self-sustaining. Startup tests were conducted in which the duration of the flow ramp from 0 to 6600 lb mass per hr (3000 kg/hr) was varied from 30 to 145 sec. It was concluded that for the flight-type system a 100-sec ramp was a good compromise between a ramp that was too short, precluding use of open-loop flow control, and a ramp that was too long, causing marginal acceleration of the turboalternator. (auth) (STAR)

13618 (N-70-11628) INVESTIGATION OF PUMP TRANSFER FREQUENCIES FROM AUXILIARY POWER TO ALTERNATOR POWER DURING STARTUP OF THE SNAP-8 SYSTEM. Soeder, Ronald H.; Lottig, Roy A. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). 13 Nov 1969. 58p. (NASA-TM-X-52712). CFSTI.

A critical parameter in the startup of the SNAP-8 system is the frequency of the battery-inverter unit that powers the four pumps prior to transfer to the power output of the accelerating turbine alternator. This frequency should be as low as possible in order to reduce inverter power and, hence, battery weight. Pumping requirements during startup, however, dictate a minimum frequency. Startup tests were conducted in which the inverter frequency requirement was determined to be 270 cycles per second. (auth) (STAR)

13619 MEASUREMENT OF CONTROL SCHEMES FOR FAST-SPECTRUM COMPACT REACTORS. Kunze, J. F.; Sims, F. L.; Byrne, J. M.; Reid, R. E. (General Electric Co., Idaho Falls, Idaho). Nucl. Appl. Technol.; 8: 226-39(Mar 1970).

Reactivity control systems based on reflector motion were considered under the 710 Advanced High Temperature Gas-Cooled Reactor Program. The three basic types of control systems studied were (1) rotation of poison control drums in the reflector, (2) outward motion of the radial reflector, and (3) longitudinal motion of the radial reflector. Reactivity and power variations caused by these types of control motion were measured on 710 Critical Experiment mockups of the power reactors. The measurements employed conventional as well as pulsed neutron techniques and showed that at least 5% ΔR control worth is easily achieved using the systems studied. The experimental configurations and measurement methods used are described, and results of the measurements are presented. (H.D.R.)

13620 ANALYSIS OF AIR BACKFLOW AND PRESSURIZATION CHARACTERISTICS IN THE NUCLEAR EXHAUST SYSTEM DUCT. Misra, B.; Fairall, R. S.; Mandelli, B. (Aerojet-General Corp., Sacramento, Calif.). J. Spacecraft Rockets; 6: 1454-6(Dec 1969).

Design requirements for ejector systems of ground testing facilities for nuclear rocket engines are presented. The ejector system described consists of downward firing position with diverted gas exhaust in a 90° elbow and a suitable exit plane. Air backflow and pressure characteristics are analyzed. 2 references. (D.C.C.)

Process Heat and Desalination Reactors

13621 STUDY AND EVOLUTION OF TECHNIQUES FOR DESALINATION. Kronberger, H. Houille Blanche; 24: 31-4 (1969). (In French).

Three principal objectives of British research in desalination are reviewed: development of the flash separation process, combined desalination-nuclear power plants, and studies of other means of desalination. Use of the AGR and SGHWR for mixed plants has 2 advantages, the possibility of refueling during operation, and reliability. Elaborate plans for mixed plants based on the AGR have been drawn up. One is a plant producing 400 MW(e) and 273,000 m^3 water/day at a cost of 0.45d/kWh and 9.25d/m^3; another unit based on the SGHWR will produce 200 MW(e) and 377.3×10^6 l water/day. The construction would require an investment of £50,000,000, and could produce electricity at a fixed 0.5d/kWh for a water charge of 4d per 500 liters. The project is illustrated, as are evaporators scheduled for delivery to the government of Kuwait. (BBB)

13622 ECONOMICS OF SEAWATER DESALINATION. Suetsuna, Ichiro (Japan Atomic Industrial Forum, Inc., Tokyo). Genshiryoku Kogyo; 15: No. 12, 41-8(Dec 1969). (In Japanese).

The present and future cost of fresh water by seawater desalination and the current cost of such water in various parts of the world are discussed. The nuclear desalination project by the MWD in southern California is described. The Japanese Government's view on desalination is presented. A description and the economics for the following methods of desalination are given: distillation, dialysis, and freezing. The desalination cost for a dual-purpose atomic power station of a capacity of 1,000 MWe output and 500,000 tons per day of water is estimated. The standard for estimating the cost of desalination by atomic energy, IAEA's "Costing Methods for Nuclear Desalination," is explained. (NSA of Japan)

Marine and Portable Power Reactors

Refer also to abstract 11710.

13623 (BAW-4099-1) ZERO-POWER TESTS ON PM-4 REACTOR CORE II. Fairburn, G. T. (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.). Jan 1970. Contract AT(30-1)-4099. 40p. Dep. CFSTI.

Zero-power tests on the PM-4 Reactor Core II are described. Detector response was measured at specific locations during core submersion and approach to criticality. The stuck-rod criteria and core uniformity were confirmed. The most reactive control rod was calibrated; the total indicated worth is 5.08% Δk/k at 68.0°F, and 4.49% Δk/k at 168.4°F. The temperature coefficient was measured up to 172.8°F. The total excess reactivity was measured using boric acid techniques. The excess indicated is 14.66% Δk/k. All tests were performed with 24 poison pins in the core and with stainless steel mockups of the thermal shrouds and pressure vessel. The tests were completed 45 days after receipt of the core. (auth)

13624 (DOCKET-50238-54) [N. S. SAVANNAH]. [Abnormal Occurrence Involving the Reactor Plant]. (First Atomic Ship Transport, Inc., New York). 14 Jan 1970. 3p. Dep. CFSTI.

The malfunction of a hydraulic valve on the emergency diesel generator aboard the N. S. Savannah is described; restart of the

diesel generator is outlined. Replacement of the damaged valve seat and subsequent diesel restart are reported. (M.L.S.)

13625 (DOCKET-50238-55) [N. S. SAVANNAH]. Operating License NS-1. Proposed License Change. (First Atomic Ship Transport, Inc., New York). 19 Jan 1970. 2p. Dep. CFSTI.

MARITIME PRESSURIZED WATER REACTOR—operation of, request for inclusion of provision for additional by-product and special nuclear material in license for (M.L.S.)

13626 (DOCKET-50238-56) [N. S. SAVANNAH]. Operating License NS-1. Technical Specifications Change No. 22. (First Atomic Ship Transport, Inc., New York). 21 Jan 1970. 2p. Dep. CFSTI.

13627 (JPRS-49698) NUCLEAR POWER PLANT SAFETY ON SHIPS. Sarkisov, A. A.; Pridatko, V. A. Translated from Morsk. Sb.; No. 12, 66-73(1969). 12p. CFSTI, GPO.

Safety problems associated with design and performance characteristics of marine reactor components are examined. Reactor operating parameters and their relationship to safety are discussed. Criteria for ensuring safety system reliability are presented. (H.D.R.)

Production Reactors

Refer also to abstracts 11666 and 13492.

Reactor Theory

Kinetics

Refer also to abstracts 13538, 13598, and 13599.

13628 (BARC-431) TECHNIQUES FOR THE DETERMINATION OF PROMPT NEUTRON DECAY CONSTANT "α" AND (β/l_p) IN REACTORS. Subbarao, K.; Nargundkar, V. R. (Bhabha Atomic Research Centre, Bombay (India)). 1969. 38p. Dep. CFSTI (U. S. Sales Only).

Techniques used for the determination of the prompt neutron decay constant are discussed with emphasis on experimental techniques, counters, data analysis, and electronics. The methods include: (1) Rosse-α; (2) Feynman or Variance-to-Mean; (3) P-Method of Noise Analysis; (4) Internal Distribution; and (5) Dead Time and Modified Dead Time. 27 references. (H.D.R.)

13629 (EIR-160) HETEROGENEOUS REACTOR LATTICE PROGRAMMES USING THE "OPEN CELL" TECHNIQUE. Alpiar, Ronald (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). Aug. 1969. 71p. Dep. CFSTI (U. S. Sales Only).

An implementation of the Heterogeneous Lattice Theory of T. Auerbach is described. The theory is a two-dimensional multigroup approach, with a lattice consisting of various types of finite-radius elements, all immersed in a single, finite, reflected moderator. Solutions are obtained in 2-dimensional cylindrical geometry, enabling the moderator flux and system eigenvalue to be computed. The characteristics of the lattice elements are determined by an auxiliary P_3 cylindrical computation. Fortran computer programs for performing the calculations are described, together with instructions for the preparation of data. 9 references. (auth)

13630 (ITEF-663) CONCERNING THE STABILITY AND FREQUENCIES OF SPATIAL XENON OSCILLATIONS (A LINEAR APPROXIMATION). Afanas'ev, A. M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1969. 24p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Frequency spectrum of Xe spatial oscillations of the reactor neutron field and the boundary of stability of these oscillations are studied by means of perturbation theory. Only linearized space-time equations in one- and two-group approximations are considered. The frequency spectrum is shown to have both discrete and continuous regions. The solution in the region of discrete spectrum is compared with the exact one. (auth)

13631 LIE SERIES STUDIES OF COUPLED REACTOR KINETICS. Sims, Charles Stephen. Norman, Okla.; Univ. of Oklahoma (1969). 210p.

Thesis.

The kinetic behavior of coupled core nuclear reactors is investigated. The coupled reactor kinetics equations, as formulated by Avery for the m-core case, are solved. The assumptions involved are that the neutron lifetimes are constants and that the coupling coefficients may be described by time varying analytic functions. The kinetics equations are solved by the use of Lie series which were introduced and named by Grobner. The Lie series solutions of Avery's equations are developed for coupling coefficients of general analytic time dependent form. Linearly and exponentially varying coupling coefficients are specific forms for which solutions are found. Five approximate Lie series solutions are also given for the linear coefficient case. The approximations are obtained by setting various combinations of derivatives equal to zero and, in some cases, using only one delayed neutron group per core. The specific cases shown utilize Pluta's method of relating the coupling coefficients to one another. Avery's equations are also solved using a prompt jump technique and a modified coupled core version of Hansen's exponential approximation which was introduced by Pluta. These solutions are compared with the various Lie series solutions for two vastly different ramp inputs to a Pu-U fast-thermal reactor. Proof of the correctness of the formal Lie series solutions is provided through the fact that they are analytic and may therefore be differentiated. This allows the solutions to be substituted back into the differential equations thus determining the correctness of the solutions. Computer programs are developed to evaluate the full Lie series solutions, the five approximate Lie solutions, the prompt jump approximation, the modified exponential approximation, and the Lie series solutions of the single core reactor kinetics equations. Recommendations for further investigation into coupled reactor kinetics using Lie series are made. (Disser. Abstr.)

13632 VOPROSY FIZIKI ZASHCHITY REAKTOROV. VYPUSK 4. (Problems in Reactor Shielding Physics. Issue 4). Broder, D. L.; Veselkin, A. P.; Egorov, Yu. A.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow; Atomizdat (1969). 228p.

Twenty-seven articles are included on the theoretical and experimental data on nuclear reactor radiation shielding. Results are given on studies of spatial, energy, and angular distribution of radiation in various homogeneous and nonhomogeneous shieldings. Albedo problems in the transport theory, extraction cross sections in homogeneous water bearing media, studies of fast neutron transport by means of multigroup system of integral equations, 0.9 MeV neutron penetration through biological shielding, formation of fast neutron spectra in various shielding material, shielding properties of metallic Li, and measurements of neutron spectra in a wide range of energies are discussed in the first ten articles. Slow neutron concentration in homogeneous media, energy distribution of epithermal neutron flux in stainless steel and Ti, attenuation of reactor radiation in cylindrical and annular water channels, γ-radiation from the Po-α-Be source with E = 4.43 MeV penetration through graphite channel inverse scattering of neutron and γ-radiation in nonhomogeneous shielding and single-rate diffusion of neutrons in non-breeding two-dimensional systems with cylindrical symmetry and use of multigroup methods for calculating of neutrons in nonhomogeneous shielding are reviewed and analyzed in the rest of the articles. (R.V.J.)

13633 ONE-DIMENSIONAL HOMOGENIZED REACTOR WITH NATURAL URANIUM AND WITH A FLATTENED SPECIFIC OUTPUT. Zezula, Rostislav (Charles Univ., Prague). Apl. Mat.; 14: 323-36(Aug 1969).

The problem of flattening the reactor specific output for the case of homogenized thermal critical reactor using natural uranium fuel is formulated mathematically in a two-group diffusion approximation and for single dimensional geometries. It is shown that this problem leads to a quasilinear biharmonic Cauchy's problem which has a two parameter family of solutions N (x; N_0, N'$_0$). The existence and stability of these solutions and the possibility of optimization of the total reactor output by a suitable selection of the N_0 and N'$_0$ parameters are investigated. 6 references. (JPRS)

13634 GEOMETRICAL EFFECTS ON ^{238}U RESONANCE INTEGRAL FOR VARIOUS SYSTEMS. Mizuta, H.; Fukai, Y. (NAIG Nuclear Research Lab., Kawasaki, Japan). J. Nucl. Energy; 23: 589-616(Dec 1969).

Geometrical effects on the resonance integral of ^{238}U were investigated using the RIMC code which calculates the resonance integrals in multi-region lattices and other geometries. Integrals were calculated for U, UO_2, and UC single rods; isolated slab; square cylinder and sphere; annular and tube-in-shell type fuel elements; hexagonal and square lattices and clusters. The temperature dependence of the integrals was also calculated for U and UO_2 fuel rods. The ^{238}U parameters used were those recommended in BNL-325. These were in close agreement with values calculated from new resonance data from the Petrel nuclear explosion. (UK)

13635 ANALYTICAL SOLUTION OF THE HELMHOLTZ EQUATION IN ONE-DIMENSION MULTI-REGION REACTORS. Bruschi, C.; Pierini, G.; Rubbia, S. (CISE, Milan). Energ. Nucl. (Milan); 17: 23-33(Jan 1970).

An analytical method is described which solves a system of Helmholtz equations over a one-dimension multiregion domain K. The method relates the vector solution on a given surface with its gradient on the same surface. The flux-to-current matrix is determined by the physical properties of K on the left or on the right side of such a surface. The criticality search for the fundamental eigenvalue can be performed allowing for the variation of all the macroscopic coefficients with respect to the control parameter, the only restriction being a monotonic dependence on it for a properly defined criticality parameter. The numerical stability of the method has been tested over a wide set of problems when applied to the multiregion two-group neutron diffusion. 8 references. (auth)

Experimental Applications

Refer also to abstract 13590.

13636 (GEAP-10046) BISYN-PERT: A TWO-DIMENSIONAL PERTURBATION MODULE FOR THE BISYN SYSTEM. Kelley, M. D.; Jones, T. R. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Apr 1969. Contract AT(04-3)-189. 26p. Dep. CFSTI.

The BISYN-PERT routine uses the two-dimensional, synthesized flux and adjoint flux distributions from the BISYN code and computes reactivity changes associated with a variety of reactor perturbations, chosen at the option of the user. Perturbation effects may be calculated by regions, specified subregions, or mesh point. Advantages and limitations of the BISYN-PERT routine are included. 2 references. (auth)

13637 (KAPL-P-3846) DOPPLER EFFECT IN ^{232}Th AT HIGH S/M VALUES. Whitesel, R. N.; Sher, R. (Stanford Univ., Calif.). [1968]. 8p. (CONF-691102-7). Dep. CFSTI.

From 17th Conference on Remote Systems Technology, San Francisco, Calif.

The results of measurements and calculations of the Doppler effect in ^{232}Th foils with surface to mass ratios of 20 and 7 cm^2/gm are presented. 6 references. (H.D.R.)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 11449, 11461, 11876, 11889, 12354, 12361, 12363, 12364, 12388, 12389, 12391, 12434, 12450, 12458, 12459, 12462, 12466, 12467, 12479, 12483, 12484, 12486, 12488, 13520, and 13637.

13638 STATIONARY GAS BUBBLES IN NARROW LIQUID-FILLED GAPS. Schad, H. O.; Bishop, A. A. (Westinghouse Electric Corp., Madison, Pa.). Nucl. Appl. Technol.; 8: 261-75(Mar 1970).

Experiments were conducted to determine the behavior of stationary gas bubbles in narrow liquid filled gaps. The measurements were carried out to help answer the question of how fission gas bubbles may behave in the sodium bond of oxide and carbide fueled rods. The hydraulic data obtained with uncracked pellets indicate that stagnant bubbles may exist even when the simulated fuel rod is vibrated. These stagnant bubbles are large enough to cause calculated hot spots in the bond. The location under an overhanging ledge formed by axial eccentric pellets was a common place for bubbles to stagnate. Possible differences between the actual fuel rod behavior in the reactor and the test conditions may be caused by heating effects which influence bubble motion, cracked pellets which prevent accumulation of fission gas in the bonding, and the release of significant amounts of fission gas only when the reactor is shut down. Equations are presented for the maximum bubble size, and the length and width of bubbles stagnated at the lips (overhang) of fuel pellets. (auth)

13639 DEVELOPMENT AND USE OF NUCLEAR ENERGY IN THE PEOPLE'S REPUBLIC OF CHINA. Rifkin, Susan Beth. IRT (Int. Res. Technol.) Nucl. J., 1: No. 4, 1-24(1969).

13640 REACTOR CONTROL ROD. Takada, Yukihiko (to Hitachi Ltd.). Japanese Patent 1969-24197. 14 Oct 1969. Filed 7 Sep 1966.

In the reactor control rod proposed, He gas produced by neutron absorption in B_4C, for example, can be contained in the rod without impairing the control rod. The control rod consists of two concentric metal tubes with many holes cut through the wall of the inner tube. The space between the two walls is packed with neutron absorbing material, and the central space formed by the inner tube is filled with porous material. Released He gas is led into the central space through the holes and contained there. The neutron absorbing material may be B or its compound, B_4C. High-temperature treated colloidal clay, or porous Al, Zr, etc., may be used as the porous material. (NSA of Japan)

13641 A REVIEW OF THE TECHNOLOGY OF PRESTRESSED-CONCRETE REACTOR PRESSURE VESSELS. Tan, Chen Pang (Franklin Inst. Research Labs., Philadelphia). Nucl. Safety; 11: 25-33(Jan-Feb 1970).

Prestressed-concrete reactor vessels (PCRV's) are adaptable to large nuclear cores and the high pressures needed for the safe and economical production of nuclear power with gas-cooled reactors. There are at present 18 PCRV's, most of which are in Great Britain and France; in the United States a PCRV for the Fort St. Vrain high-temperature gas-cooled reactor is under construction. The basic problems facing the designer and constructor of PCRV's were (1) lack of applicable codes, (2) little knowledge of long-term behavior of concrete under multiaxial stresses at high temperature, (3) little information on stress concentrations in concrete due to penetrations of various sizes and to the anchorages, (4) porosity of concrete, and (5) limited capacity of commercially available prestressing systems. Most of these problems have been resolved through engineering ingenuity complemented with extensive research and development. Satisfactory designs of PCRV's have been accomplished by developing sophisticated analytical methods and testing structural models. PCRV's appear to be favored for advanced reactors because of adaptability with respect to size and pressure. (auth)

13642 AUTOMATION POSSIBILITIES OF ULTRASONIC CONTROL OF FUEL RODS. Obraz, Jaroslav (Research Inst. for Machine Design, Bechovice, Czech.). Jad. Energ.; 16: 16-19(1970). (In Czech).

Ultrasonic equipment for automatic testing the fuel rods for the atomic power stations was developed. The fuel rod under test comes through a set of ultrasonic probes immersed in tetrachloride. The transmission pulse technique is used for testing the adhesion quality of uranium wire to the ripped casing and the echo reflection pulse technique detects the transverse cracks in the mentioned casing. The probes are connected to electronic devices directly recording the flaws. The results of laboratory tests are briefly discussed. 2 references. (auth)

13643 DEVICE FOR ALIGNING REACTOR-USE CASK. Wase, Keizo (to Hitachi Ltd.). Japanese Patent 1969-23600. 7 Oct 1969. Filed 3 Jun 1964.

The device proposed for aligning a cask is used for positioning the fuel-containment tubes of the cask onto the top of vertical fuel-guide holes of a reactor. Using a periscope, the positioning is precise, and the degree of eccentricity can also be measured. The device essentially consists of a periscope and a plate with circular graduation. The cask, with two vertical containment tubes, is set on the top of a reactor with corresponding fuel-guide holes, and the vertical part of the periscope is between the two tubes. (NSA of Japan)

13644 REACTORS AND COMPUTERS AT ARGONNE: THE APPLICATION OF COMPUTERS TO REACTOR PROBLEMS OVER THE PAST TWO DECADES. Butler, Margaret K. Argonne Nat. Lab. Rev.; 5: 77-86(Oct 1969).

The periods of digital computer development include: AVIDAC-UNIVAC from 1953 to 1957; GEORGE; the Argonne 704 from 1957 to 1966; the CDC from 1963 to 1967; and IBM systems. 31 references. (D.C.C.)

13645 ELECTRICAL PENETRATORS FOR NUCLEAR REACTOR CONTAINMENT VESSELS: WIRE TERMINATION TECHNIQUES AND FAULT CURRENT DETERMINATIONS. Hagmann, R.; Dunn, D. L. Combustion; 41: No. 5, 19-22(Nov 1969).

Some nuclear penetrator history as well as some of the design criteria and requirements currently being proposed relating to the manufacture of nuclear containment structure electrical penetrators are summarized. A number of problems which have required solutions in order to arrive at the present state of the art "third generation" penetrator devices are examined. A discussion of fault current requirements which, at this time, are under further intensive investigation and test is presented. Firmly established criteria for fault testing are not available. Current penetrator design in this area is predicated on somewhat arbitrary values of fault currents which have been extended from the magnitudes relating to the associated switchgear and protective devices. Various other design and operating parameters are also covered which have been found to be of importance in penetrator design. (auth)

GENERAL

13646 (AEC-tr-6931/6) NUKLEONIKA. Translation of Nukleonika; 13: 591-718(1968). 128p. (TT-68-50011/6). Dep. CFSTI.

13647 (ANL-7593) MOLECULAR-BEAM DEPOSITION OF NICKEL CHLORIDE ON METAL SUBSTRATES. Holt, Ben D. (Argonne National Lab., Ill.). Jul 1969. Contract W-109-eng-38. 75p. Dep. CFSTI.

Sticking coefficients of nickel chloride on polycrystalline molybdenum, gold, and nickel were measured by exposing the metal targets, over a range of 80 to 750°K, to a molecular beam of $NiCl_2$ at 836°K. Each target, heated to a constant temperature by a radiometer-controlled electron gun, was enclosed in a liquid-nitrogen-cooled collector for the capture of molecules reevaporated from the heated surface. The total amount of $NiCl_2$ striking the target in each 90-min exposure corresponded to >30 monomolecular layers on the substrate. The coefficient-versus-temperature curve differed drastically from the corresponding theoretical curve calculated on the basis of equilibrium vapor pressure and beam geometry. Whereas the theoretical coefficient changed from near unity to zero over a span of about 60°, the experimental coefficient did so over 265°. Within the range of variation, the coefficient was significantly enhanced by a thin coating of $NiCl_2$ (>30 monomolecular layers) predeposited at 80°K. No systematic variation of the coefficient with duration of exposure was detected. The microscopic appearance of the deposit (at 100× magnification) was influenced by grain orientation of the polycrystalline metal-substrate. When gold targets were used, an incomplete recovery of total nickel indicated diffusion into the substrate. (auth)

13648 (ANL/ES-CC-5) AN URBAN ATMOSPHERIC DISPERSION MODEL. Chicago Air Pollution Systems Analysis Program. Roberts, J. J.; Croke, E. J.; Kennedy, A. S. (Argonne National Lab., Ill. Chicago Dept. of Air Pollution Control, Ill. National Air Pollution Control Administration, Washington, D. C.). Oct 1969. Contract W-31-109-eng-38. 116p. Dep. CFSTI.

13649 (ANL/ES-CEN-1000) REVIEW OF BRITISH PROGRAM ON FLUIDIZED-BED COMBUSTION; REPORT OF U. S. TEAM VISIT TO ENGLAND, FEBRUARY 17-28, 1969. Carls, E. L. (Argonne National Lab., Ill.). Aug 1969. Contract W-31-109-eng-38. 48p. Dep. CFSTI.

13650 (BDX-613-126) PERCUSSIVE ARC WELDING FOR ELECTRICAL ASSEMBLIES. Cheramy, Edward R. (Bendix Corp., Kansas City, Mo.). Sep 1969. Contract AT(29-1)-613. 23p. Dep. CFSTI.

13651 (BDX-613-127) INTERFEROMETER PRISM PDR 187. Schoeppner, M. P. (Bendix Corp., Kansas City, Mo.). Sep 1969. 13p. Dep. CFSTI.

Background of interferometric length measurement is given to support the description of a new miniature prism designed to simplify and stabilize a laser interferometer configuration. Advantages and applications of the improved interferometer system are presented. (auth)

13652 (BNL-14249) SOLUBILITY AND REACTIONS OF OXYGEN IN SODIUM. Minushkin, B.; Kissel, G. (Brookhaven National Lab., Upton, N. Y.). [1968]. 8p. Dep. CFSTI.

13653 (BNL-50174) THE MOLECULAR BASIS OF ENZYME ACTION: CURRENT VIEWS. Brookhaven Lecture Series No. 75. Shaw, Elliott N. (Brookhaven National Lab., Upton, N. Y.). 29 May 1968. 16p. Dep. CFSTI.

13654 (BNL-50191) MARKED MONEY IN THE CARBOHYDRATE-FAT ECONOMY. Brookhaven Lecture Series No. 84. Shreeve, Walton W. (Brookhaven National Lab., Upton, N. Y.). 14 May 1969. 17p. Dep. CFSTI.

13655 (BNWL-1248) GRAINS: A QUASI-DYNAMIC CODE FOR COMPUTER SIMULATION EXPERIMENTS OF POINT AND LINE DEFECTS IN METALS. Dahl, R. E.; Beeler, J. R. Jr.; Bourquin, R. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan 1970. Contract AT(45-1)-1830. 87p. Dep. CFSTI.

13656 (CONF-690506-3) ELECTROREDUCTION OF Bi(III) IN MOLTEN NaCl-$AlCl_3$. Torsi, G.; Mamantov, G. (Tennessee Univ., Knoxville. Dept. of Chemistry). [1968]. Contract AT-(40-1)-3518. 18p. Dep. CFSTI.

From 1st International Symposium on Silicon Materials Science and Technology, New York.

13657 (COO-1198-685) ELECTROMIGRATION AND CHEMICAL DIFFUSION IN TITANIUM CARBIDE. Kohlstedt, David Lee (Illinois Univ., Urbana). Feb 1970. Contract AT(11-1)-1198. 241p. Dep. CFSTI.
Thesis.

13658 (COO-1498-7) CHEMICAL BASIS FOR SPECIFICITY OF AMINO ACID-tRNA SYNTHETASE. Progress Report. Mehler, Alan H. (Marquette School of Medicine, Inc., Milwaukee, Wis. Dept. of Biochemistry). Dec 1969. Contract AT(11-1)-1498. 5p. Dep. CFSTI.

13659 (COO-1498-8) BINDING OF TRANSFER RNA AND ARGININE TO THE ARGININE TRANSFER RIBONUCLEIC ACID SYNTHETASE OF ESCHERICHIA COLI. Mitra, Samir K.; Chakraburtty, Kalpana; Mehler, Alan H. (Marquette School of Medicine, Inc., Milwaukee, Wis. Dept. of Biochemistry). [1969]. 43p. Dep. CFSTI.

13660 (COO-1498-9) ANALYSIS OF THE AMINO ACID BINDING TO THE PROLINE-tRNA SYNTHETASE OF E. COLI. Papas, Takis S.; Mehler, Alan H. (Marquette School of Medicine, Inc., Milwaukee, Wis. Dept. of Biochemistry). [1969]. Contract AT(11-1)-1498. 36p. Dep. CFSTI.

13661 (COO-1591-9) CALCULATIONS OF STRAINS AND STRAIN RATES IN BENDING CREEP TESTS. Terwilliger, G. R.; Gordon, R. S. (Utah Univ., Salt Lake City. Division of Materials Science and Engineering). Dec 1969. Contract AT-(11-1)-1591. 13p. Dep. CFSTI.

13662 (COO-1591-10) IMPURITY EFFECTS ON THE CREEP OF POLYCRYSTALLINE MAGNESIUM AND ALUMINUM OXIDES AT ELEVATED TEMPERATURES. Technical Progress Report, December 19, 1968-December 18, 1969. Gordon, Ronald S. (Utah Univ., Salt Lake City. Div. of Materials Science and Engineering). Contract AT(11-1)-1591. 31p. Dep. CFSTI.

13663 (COO-1771-2) NUTRIENT CYCLING AND PRODUCTIVITY OF DYSTROPHIC LAKE-BOG SYSTEMS. Part A. Technical Progress Report. Hooper, Frank F. (Michigan Univ., Ann Arbor. Dept. of Wildlife and Fisheries). Dec 1969. Contract AT(11-1)-1771. 60p. Dep. CFSTI.

13664 (COO-1792-4) TECHNICAL PROGRESS REPORT. Krishna, V. G. (Arizona Univ., Tucson. Dept. of Chemistry). 31 Jan 1970. Contract AT(11-1)-1792. 6p. Dep. CFSTI.

13665 (COO-2012-2) STUDIES ON INTRAOCULAR TRANSPORT OF TAURINE. II. ACCUMULATION IN THE RABBIT LENS. Reddy, V. N. (Oakland Univ., Rochester, Mich. Inst. of Biological Sciences). [1969]. Contract AT(11-1)-2012. 28p. Dep. CFSTI.

13666 (COO-2058-1) MOLECULAR STRUCTURE STUDIES: A GAS PHASE ELECTRON DIFFRACTION UNIT EMPLOYING COUNTING TECHNIQUES. Technical Progress Report, June 1-December 18, 1969. Thompson, H. Bradford (Toledo Univ., Ohio). 8p. Dep. CFSTI.

13667 (CTC-21) A STUDY OF CONTROL SYSTEM SENSITIVITY. Mankin, James Bradley Jr. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). Dec 1969. Contract W-7405-eng-26. 241p. Dep. CFSTI.

13668 (CTC-24) TURBULENCE ANALYSIS PROGRAM (TURBAN1). Browell, Robert W.; Crass, Benny L. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). 16 Jan 1970. Contract W-7405-eng-26. 44p. Dep. CFSTI.

A FORTRAN coded program developed to provide computational assistance for the study of turbulence phenomena in research compressor systems is described. Specifically, the program computes turbulence intensity, turbulence components and Reynolds' stresses using data obtained from hot-wire anemometer measurements. The data input is in the form of punched cards. The program is in FORTRAN IV for the IBM 360/65 computer. (auth)

13669 (CTC-INF-980(and Add.1)) NOTES ON HEATING: AN IBM 360 HEAT CONDUCTION PROGRAM. Turner, W. D.; Crowell, J. S. (Union Carbide Corp., Oak Ridge, Tenn. Com-

puting Technology Center). 21 Nov 1969. Contract W-7405-eng-26. 84p. Dep. CFSTI.

13670 (CU-3957-6) THE EFFECT OF CHEMICAL MODIFICATION OF DNA ON ITS MACROMOLECULAR STRUCTURE. Progress Report, May 1, 1969–January 31, 1970. Krasna, Alvin I. (Columbia Univ., New York. Dept. of Biochemistry). 9p. Dep. CFSTI.

13671 (EGG-1183-524) AIRBORNE SATELLITE COMMUNICATIONS DURING AURORAL STUDIES. Final Report. Technical Report Number B-4101. Sundstrom, Carl F.; Garcia, Manual M. (EG and G, Inc., Bedford, Mass. Eastern Science and Technology Div.). Sep 1969. 19p. Dep. CFSTI.

A series of auroral studies flights flown during March 1968 included communications equipment experiments designed to test the efficacy of incorporation of a satellite link in maintaining two-way communications between aircraft flying at high altitude at conjugate auroral points located in opposite hemispheres. The ground test, flight check, and actual auroral missions communications showed that marked improvement in coordination between the aircraft and between the experimental systems aboard the separate aircraft was possible using the ATS-1 satellite. (auth)

13672 (GEPP-76) DESIGN EQUATIONS FOR A CURRENT BALANCING CHOKE. Roubik, J. C. (General Electric Co., St. Petersburg, Fla. Neutron Devices Dept.). 18 Nov 1969. Contract AT(29-2)-656. 27p. Dep. CFSTI.

13673 (IN-1342) PROJ: ALGORITHM AND COMPUTER PROGRAMS FOR THE HIDDEN LINE PROBLEM FOR SINGLE VALUED SURFACES. Lintner, M. A. (Idaho Nuclear Corp., Idaho Falls). Dec 1969. Contract AT(10-1)-1230. 40p. Dep. CFSTI.

Let $\phi(x,y)$ be a single valued continuous surface. For numerical representation let the domain of ϕ be the set of coordinates $\{(x_i,y_j)\}$, $i = 1,2,\ldots,n$, $j = 1,2,\ldots,m$, and the surface itself be the set $\{\phi(x_i,y_j)\}$. For graphical representation let the points $\{\phi(x_i,y_j)\}$ be connected by directed line segments according to the ordering $\phi(x_i,y_j)$, $\phi(x_i,y_{j+1})$, $\phi(x_{i+1},y_{j+1})$, $\phi(x_{i+1},Y_j)$, $\phi(x_i,y_j)$, $i = 1,2,\ldots,n-1$, $j = 1,2,\ldots,m-1$, so that the surface is composed of a set of individual facets, each of which is bounded by a negatively oriented curve composed of four distinct line segments. The hidden-line problem in this case is to find an efficient computer algorithm that will determine which line segments, or parts of line segments, are visible from a given vantage point. An algorithm which was written to handle this special but important case of the general hidden line problem is described. It is also intended that this will serve as the user's guide for the computer programs based on the algorithm. (auth)

13674 (IN-1360) BIBLIOGRAPHY OF LASER PUBLICATIONS OF INTEREST TO EMISSION SPECTROSCOPISTS. IV. Baldwin, Jon M. (ed.) (Idaho Nuclear Corp., Idaho Falls). Jan 1970. Contract AT(10-1)-1230. 15p. Dep. CFSTI.

13675 (IS-T-329) SUBSTITUTION REACTIONS OF DICHLORO(ETHYLENEDIAMINE)PLATINUM(II). Coley, Ronald Frank (Ames Lab., Iowa). Nov 1969. Contract W-7405-eng-82. 99p. Dep. CFSTI.
Thesis.

13676 (IS-T-337) LOW TEMPERATURE THERMAL EXPANSION OF COPPER, SILVER, GOLD, AND ALUMINUM. McLean, Kent Otho (Ames Lab., Iowa). Nov 1969. Contract W-7405-eng-82. 97p. Dep. CFSTI.
Thesis.

13677 (IS-T-342) APPARENT MOLAL VOLUMES OF SOME DILUTE AQUEOUS RARE EARTH SALT SOLUTIONS AT 25°C. Cullen, Peter Francis (Ames Lab., Iowa). Nov 1969. Contract W-7405-eng-82. 110p. Dep. CFSTI.
Thesis.

The apparent molal volumes, ϕ_v, of aqueous solutions of La, Nd, Gd, and Lu perchlorates; Pr, Sm, Eu, Gd, Tb, Dy, Ho, Tm, and Lu nitrates; and Eu, Tm, and Lu chlorides were determined from 0.0015 molar to about 0.15 molar at 25°C. The apparent molal volumes were calculated from the specific gravities determined by a magnetically controlled float. When the apparent molal volumes at infinite dilution of a rare earth anion series are plotted against rare earth ionic radius, ϕ_v^0 decreases from La to Nd and from Tb to Lu but increases from Nd to Tb with decreasing ionic radius. The variation was found to be independent of the anion. An analysis of the components comprising ϕ_v^0 determined that the trend was present in the term reflecting ion-solvent interactions. This is in agreement with the suggestion that a change in coordination of the rare earth ions occurs in the region from Nd to Tb. (auth)

13678 (LA-4299) INTERSECTION OF A RAY WITH A SURFACE OF THIRD OR FOURTH DEGREE. Cashwell, E. D.; Everett, C. J. (Los Alamos Scientific Lab., N. Mex.). Sep 1969. Contract W-7405-eng-36. 9p. Dep. CFSTI.

13679 (LA-4300) MERCURY AS A HEAT PIPE FLUID. Deverall, J. E. (Los Alamos Scientific Lab., N. Mex.). Oct 1969. Contract W-7405-eng-36. 11p. Dep. CFSTI.

13680 (NYO-906-87) KINETICS AND STRUCTURAL STUDIES OF CHELATES β-DIKETONES WITH TRANSITION AND RARE EARTH METALS. Progress Report, April 1, 1969–March 31, 1970. Cefola, Michael (Fordham Univ., New York. Dept. of Chemistry). 21 Jan 1970. Contract AT(30-1)-906. 39p. Dep. CFSTI.

13681 (NYO-1725-36) MECHANISMS OF ACID-BASE CATALYSIS AND STUDIES IN DEUTERIUM OXIDE AS SOLVENT. Technical Progress Report, January 1–December 31, 1969. Long, F. A. (Cornell Univ., Ithaca, N. Y. Dept. of Chemistry). Contract AT(30-1)-1725. 7p. Dep. CFSTI.

13682 (NYO-2391-107) FAR-INFRARED FREQUENCY DEPENDENCE OF THE ROOM TEMPERATURE SURFACE RESISTANCE OF LEAD. Report No. 1281. Gillis, Richard Dixon (Cornell Univ., Ithaca, N. Y. Materials Science Center). Jan 1970. Contract AT(30-1)-2391. 41p. Dep. CFSTI.
Thesis.

13683 (NYO-2391-108) EXPERIMENTAL PHONON PHYSICS. Progress Report, April 1, 1969–March 31, 1970. Pohl, R. O.; Krumhansl, J. A.; Sievers, A. J. (Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics). Contract AT-(30-1)-2391. 20p. Dep. CFSTI.

13684 (NYO-3402-9) MAGNETO-THERMODYNAMICS OF PARA- AND ANTIFERROMAGNETS. Final Report, June 1, 1964–May 31, 1969. Butera, Richard A. (Pittsburgh Univ., Pa. Dept. of Chemistry). Contract AT(30-1)-3402. 11p. Dep. CFSTI.

13685 (NYO-3536-13) IN VITRO BIOSYNTHESIS OF PLANT PROTEINS AND NUCLEIC ACID. Final Report, April 15, 1965–July 31, 1969. (Maryland Univ., College Park. Dept. of Botany). Contract AT(30-1)-3536. 6p. Dep. CFSTI.

13686 (NYO-3912-2) COBALT SORPTION ON SURFACE REACTIVE MINERALS IN THE GLACIAL ENVIRONMENT. Progress Report, February–December 1969. Reynolds, R. C. Jr. (Dartmouth Coll., Hanover, N. H.). 8 Dec 1969. Contract AT(30-1)-3912. 10p. Dep. CFSTI.

13687 (NYO-4079-4) TRANSPORT AND MAGNETIC PHENOMENA IN CHROMIUM AND IRON ALLOYS. [PART] I. Technical Progress Report, April 1, 1969–January 1, 1970. Arajs, Sigurds (Clarkson Coll. of Tech., Potsdam, N. Y.). 7p. Dep. CFSTI.

13688 (ORNL-4452) SIGNIFICANCE OF SPIDER PREDATION IN THE ENERGY DYNAMICS OF FOREST FLOOR ARTHROPOD COMMUNITIES. Moulder, B. C.; Reichle, D. E.; Auerbach, S. I. (Oak Ridge National Lab., Tenn.). Jan 1970. Contract W-7405-eng-26. 170p. Dep. CFSTI.
Thesis. Submitted by B. C. Moulder to Univ. of Tennessee, Knoxville.

13689 (ORNL-IBP-69-1) PHENOLOGICAL RECORDS OF VASCULAR PLANTS AT OAK RIDGE, TENNESSEE. Taylor, Fred G. (Oak Ridge National Lab., Tenn.). Dec 1969. Contract W-7405-eng-26. 46p. Dep. CFSTI.

Date of first flowering for 225 vascular plant species has been recorded during the spring seasons from 1963 to 1969 at Oak Ridge, Tennessee. Sixty species were woody, whereas 165 were classified as herbaceous. This array was comprised of 164 genera representing 70 families. The woody taxa contained observations on 48 genera from 28 families, and the herbaceous plants consisted of 116 genera from 42 families. More species were observed to flower in April than in any other month. Twenty woody species flowered during that month in contrast to 77 herbaceous species. This total represented 52 genera among the herbaceous plants and 17 among the woody plants. These observations are intended to call attention to date of first flowering, and in many cases illustrate the variation observed within a seven year period. Since vegetative growth usually diminishes with the onset of the repro-

ductive life cycle, knowledge concerning date of flowering would be especially valuable in analysis of ecosystems and in biomass estimations. (auth)

13690 (ORNL-TM-2855) COMPUTER PROGRAM FOR CALCULATING THE CONFIGURATIONAL CHANGES IN NON-RANDOM ALLOYS DUE TO DEFORMATION. Williams, R. O. (Oak Ridge National Lab., Tenn.). Feb 1970. Contract W-7405-eng-26. 23p. Dep. CFSTI.

13691 (ORNL-tr-2262) VARIOUS EXPERIMENTAL PROBLEMS AND REINVESTIGATION OF EXPERIMENTAL RESULTS RELATIVE TO THE HEAT TREATMENT OF CARBON UNDER HIGH PRESSURE. Inagaki, Michio; Kamiya, Kanichi; Noda, Tokiti. Translated for Oak Ridge National Lab., Tenn., from Kogyo Kagaku Zasshi; 71: 652-7(1968). 20p. Dep. CFSTI.

13692 (ORO-672, pp 97-9) AMOUNTS OF VARIOUS MINERAL ELEMENTS IN CATTLE PLASMA AND HAIR AT INTERVALS DURING THE YEAR. Hall, R. F. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

The mineral level of the tissues of Hereford cows from the life-study herd with and without symptoms of grass tetany was studied over a one-year period. Seasonal hair and plasma values of calcium and magnesium appeared at a constant ratio; the low point in content seemed to coincide with the onset of calving season and the incidence of grass tetany. (C.O.)

13693 (ORO-672, pp 127-41) FIXATION AND C-AXIS SPACINGS RESULTING FROM REACTIONS OF VARIOUS COMBINATIONS OF CATION SPECIES WITH K-EXTRACTED, Na-SATURATED VERMICULITE. Klobe, W. D. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

The effects of Cs saturation on Na exchangeability were studied by preparing systems containing a constant amount of vermiculite, but with different amounts of added Cs and Na. Methods used to prepare vermiculite samples that are virtually void of K are discussed. In each system over 98% of the added Cs was sorbed, and the amount of sorbed Cs fixed against self-exchange was around 99, 98, and 97% with K saturations of 40.7, 47.6, and 52.7%, respectively. As larger quantities of CsCl were added, a greater fraction of the sorbed Na became fixed against exchange with ^{22}Na, probably due to entrapment upon contraction of the mineral layers. Also, increases in total Cs + K caused a greater fraction of the sorbed Na to become fixed. The amount of Na released from the vermiculite was directly proportional to the amount of Cs sorbed, and the sorbed Cs was exchanged almost entirely with Na. The amount of sorbed K was relatively fixed despite differences in Cs amounts. With each increment of added K, the auto-gamma and total analysis results gave good agreement on K saturation of the exchange capacity. X-ray diffraction patterns showed that as increasing amounts of KCl were added to the K-extracted vermiculite, the 14.7-Å peak disappeared and a single broader 12-Å hydrobiotite peak formed, indicating a regular interstratification of collapsed 10-Å biotite and expanded 14-Å vermiculite layer spacings. As increasing amounts of CsCl were added, the C-axis spacing decreased slightly, but with all combinations of Cs + K there was still a single hydrobiotite peak, indicating a regular interstratification of collapsed and expanded layers. (C.O.)

13694 (ORO-2036-13) IMPURITY TRACER DIFFUSION IN SILVER HALIDES. Batra, A. P.; Laskar, A. L.; Brebec, G.; Slifkin, L. (North Carolina Univ., Chapel Hill). [1969]. Contract AT(40-1)-2036. 12p. (CONF-690936-1). Dep. CFSTI.

From Symposium on Diffusion Processes, Glasgow, Scotland.

13695 (ORO-2410-16) NITRATE AND AMMONIUM UPTAKE AND ASSIMILATION AND THEIR INFLUENCE ON STRONTIUM UPTAKE AND TRANSLOCATION BY HIGHER PLANTS. Annual Progress Report, May 1, 1969–April 30, 1970. Jackson, William A. (North Carolina State Univ., Raleigh. Dept. of Soil Science). Jan 1970. Contract AT(40-1)-2410. 62p. Dep. CFSTI.

13696 (ORO-3628-10) MECHANISMS OF INNATE IMMUNITY. III. FURTHER RESOLUTION AND BIOLOGICAL CHARACTERIZATION OF POLYMORPHONUCLEAR LEUKOCYTE LYSOSOMAL COMPONENTS. Comprehensive Progress Report, March 1, 1967–November 30, 1969. Spitznagel, John K. (North Carolina Univ., Chapel Hill). Contract AT(40-1)-3628. 28p. Dep. CFSTI.

13697 (ORO-3662-2) CONNECTIVITY IN DIGITAL PICTURES. Technical Report No. 68-81. Rosenfeld, Azriel (Maryland Univ., College Park. Computer Science Center). Nov 1968. Contract AT(40-1)-3662. 44p. Dep. CFSTI.

13698 (ORO-3662-3) NOISE CLEANING IN BINARY-VALUED DIGITAL PICTURES USING "PROPAGATION" PROCESSES. Technical Report No. 69-91. Rosenfeld, Azriel; Park, Chan M.; Strong, James P. (Maryland Univ., College Park. Computer Science Center). May 1969. Contract AT(40-1)-3662. 55p. Dep. CFSTI.

13699 (ORO-3662-4) EDGE AND CURVE ENHANCEMENT IN DIGITAL PICTURES. Technical Report No. 69-93. Rosenfeld, Azriel; Thomas, Richard B.; Lee, Yung H. (Maryland Univ., College Park. Computer Science Center). May 1969. Contract AT(40-1)-3662. 155p. Dep. CFSTI.

13700 (ORO-3797-3) LANTHANIDE IONS AS SENSITIVE PROBES IN INTERMOLECULAR ENERGY TRANSFER AND ORGANIC PHOTOCHEMISTRY. Annual Progress Report. Filipescu, Nicolae (George Washington Univ., Washington, D. C. Dept. of Chemistry). Jan 1970. Contract AT(40-1)-3797. 5p. Dep. CFSTI.

13701 (SC-CR-69-3270) EVALUATION OF A TRANSFER COEFFICIENT APPROACH FOR UNEQUAL DIFFUSION COEFFICIENTS. Bartlett, Eugene P.; Grose, Ronald D. (Aerotherm Corp., [Mountain View], Calif.). 30 Jun 1969. Contract 48-7407. 130p. Dep. CFSTI.

For Sandia Labs., Albuquerque, N. Mex.

13702 (SC-CR-69-3289) SURFACE CONDITIONS IN SLIP-FLOW WITH MASS TRANSFER. Whitehead, R. E.; Davis, R. T. (Virginia Polytechnic Inst., Blacksburg. Dept. of Engineering Mechanics). Dec 1969. Contract 48-7795. 20p. (VPI-E-69-11). Dep. CFSTI.

For Sandia Labs., Albuquerque, N. Mex.

13703 (SC-DR-69-661) AEROELASTIC BENDING ANALYSIS OF A TERRIER-TOMAHAWK 9 SOUNDING ROCKET VEHICLE. Matejka, D. Q. (Sandia Labs., Albuquerque, N. Mex.). Nov 1969. 40p. Dep. CFSTI.

13704 (SC-DR-69-760) MODELING FOR THE SCEPTRE CIRCUIT ANALYSIS PROGRAM. Harstad, D. N. (Sandia Labs., Albuquerque, N. Mex.). Nov 1969. 18p. Dep. CFSTI.

The permanent model library which was developed for use with the SCEPTRE program is described. In order to use the model library, the user must be aware of the characteristics and limitations of each model. (auth)

13705 (SC-DR-69-870) DYNAMIC RESPONSE OF CORE-FILLED CYLINDERS. Prasthofer, Peter H. (Sandia Labs., Albuquerque, N. Mex.). Jan 1970. 18p. Dep. CFSTI.

13706 (SC-M-69-401-A(Pt.2)) PROGRAM WINNOW (PROGRAMMER'S MANUAL). Faw, Lewis A. (Sandia Labs., Albuquerque, N. Mex.). Jan 1970. 137p. Dep. CFSTI.

13707 (SC-RR-69-486) MINIMAL UNIFORM COVERS ON FINITE SETS. Simmons, Gustavus J. (Sandia Labs., Albuquerque, N. Mex.). Dec 1969. 108p. Dep. CFSTI.

13708 (SC-RR-69-752) EVALUATION OF PROBABILITIES ASSOCIATED WITH A FIXED SAMPLE SELECTION PROCEDURE. Amos, Donald E.; Daniel, Sharon L. (Sandia Labs., Albuquerque, N. Mex.). Dec 1969. 50p. Dep. CFSTI.

The sampling procedure under consideration consists of making m observations on each of k + 1 exponentially distributed populations, k of which have means of one while the (k + 1)st has mean $\theta > 1$. The object is to identify the (k + 1)st population by summing the m independent observations for each sample and picking the population based on the largest sample sum. An integral for the probability of a correct selection is developed for this procedure. An analysis for the quadrature is presented together with a computer code which produces the sample size m needed to achieve a probability α of correct selection, given k and θ. Representative results are tabulated for $\alpha = 0.90, 0.95, 0.99, 0.995, 0.999$ with k + 1 = 2, 10, 100, 500, 1000 and $\theta = 1.10, 1.25\ (0.25)\ 3.00$. (auth)

13709 (SC-RR-70-155) YAW OF REPOSE ON SPINNING SHELLS. Vaughn, Harold R.; Wilson, Gerald G. (Sandia Labs., Albuquerque, N. Mex.). Jan 1970. 26p. Dep. CFSTI.

13710 (TID-4500(55th Ed.)) STANDARD DISTRIBUTION FOR UNCLASSIFIED SCIENTIFIC AND TECHNICAL REPORTS ARRANGED BY CATEGORY NUMBER. Mayfield, Hannah B. (ed.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). 1 Dec 1969. 120p. CFSTI.

13711 (TID-4552(Rev.7)) SUBJECT SCOPE OF NUCLEAR SCIENCE ABSTRACTS. Volume 24, Number 1. Abstracts 1-2090. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). 15 Jan 1970. 68p. DTIE Free.

13712 (TID-25317) STATIONARY VALUES OF THE RATIO OF QUADRATIC FORMS SUBJECT TO LINEAR CONSTRAINTS. Golub, Gene H.; Underwood, Richard (Stanford Univ., Calif. Dept. of Computer Science). Nov 1969. 22p. (CS-142). Dep. CFSTI.

Let A be a real symmetric matrix of order n, B a real symmetric positive definite matrix of order n, and C and $n \times p$ matrix of rank r with $r \leq p < n$. We wish to determine vectors $\underline{x}$ for which $\underline{x}^T A\underline{x}/\underline{x}^T B\underline{x}$ is stationary and $C^T\underline{x} = \underline{0}$, the null vector. An algorithm is given for generating a symmetric eigensystem whose eigenvalues are the stationary values and for determining the vectors $\underline{x}$. Several Algol procedures are included. (auth)

13713 (TID-25325) STUDIES WITH TROPICAL AND SUB-TROPICAL MICROALGAE. Annual Progress Report. Bunt, J. S. (Miami Univ., Fla. Rosenstiel School of Marine and Atmospheric Sciences). [1969]. Contract AT(40-1)-3795. 21p. Dep. CFSTI.

13714 (UCLA-34-P-124-11) ANNUAL REPORT, OCTOBER 15, 1968-OCTOBER 1, 1969. (California Univ., Los Angeles). Contract AT(11-1)-34. 7p. Dep. CFSTI.

13715 (UCRL-19379) KINETICS OF AMINO ACID TRANSPORT ACROSS BONE MARROW CELL MEMBRANES. Lin, Max Shiuming (California Univ., Berkeley. Lawrence Radiation Lab.). Oct 1969. Contract W-7405-eng-48. 97p. Dep. CFSTI.

Thesis.

13716 (UCRL-50731) HALON 1301 FIRE EXTINGUISHING SYSTEM FOR TRAILERS. Gaskill, J. R.; Leonhart, E. C.; Sanborn, E. N. (California Univ., Livermore. Lawrence Radiation Lab.). 19 Aug 1969. 23p. Dep. CFSTI.

Factors in the selection of equipment and extinguishants for an automatic fire extinguishing system to be used in instrumentation trailers are discussed. The design of such a system for LRL trailers is described. This design includes automatic combustion detection, fault detection, and Halon 1301 extinguishant discharge. The results of system tests and suggestions for portable versatile packaging are given. The appendices give test data, actual layout, and design details. (auth)

13717 (UCRL-50751) THE LINEAR VISCOELASTIC RESPONSE OF LX-07-1. Murray, R. C.; Moen, W. G. (California Univ., Livermore. Lawrence Radiation Lab.). 18 Sep 1969. 30p. Dep. CFSTI.

13718 (UCRL-50764) A STATISTICAL MODEL FOR THE LIFE OF COMPOSITE MATERIALS UNDER ARBITRARY, TIME-VARYING LOADING. Sweet, Larry M.; Robinson, E. Y. (California Univ., Livermore. Lawrence Radiation Lab.). 7 Oct 1969. 18p. Dep. CFSTI.

13719 (UCRL-71983) IMPROVED CIRCUIT MODELS FOR INDUCTORS WOUND ON FERRITE CORES. Buntenbach, R. W.; McCann, R. B. (California Univ., Livermore. Lawrence Radiation Lab.). 29 Dec 1969. 15p. (CONF-691205-1). Dep. CFSTI.

From 3rd Asilomar Conference on Circuits and Systems, Pacific Grove, Calif.

13720 (UCRL-72093) TIME-SHARE VERSUS DEDICATED SYSTEMS AND HARDWARE-SOFTWARE TRADEOFFS. Anderson, Roger E. (California Univ., Livermore. Lawrence Radiation Lab.). 17 Dec 1969. 39p. (CONF-690938-1). Dep. CFSTI.

From Stored Program Controller Symposium, Albuquerque, N. Mex.

13721 (UCRL-Trans-1404) OPTICAL ANALOGY OF PULSE COMPRESSION. Tournois, Pierre. Translated for Univ. of California, Lawrence Radiation Lab., Berkeley, from Compt. Rend.; 258: 3839-42(1964). 6p. Dep. CFSTI.

13722 (UCRL-Trans-1405) INTERFEROMETER USEABLE FOR COMPRESSION OF FREQUENCY-MODULATED PULSES OF LIGHT. Gires, Francois; Tournois, Pierre. Translated for Univ. of California, Lawrence Radiation Lab., Berkeley, from Compt. Rend.; 258: 6112-115(1964). 5p. Dep. CFSTI.

13723 (UCRL-Trans-10425) EFFECT OF BOUNDARIES OF A BODY ON THE DEVELOPMENT OF CRACKS DUE TO BRITTLE FRACTURE. Barenblatt, G. I.; Cherepanov, G. P. Translated by F. D. Jones for Univ. of California, Lawrence Radiation Lab., Livermore, from Izv. Akad. Nauk SSSR, Otd. Tekh. Nauk, Mekh. Mashinostr.; No. 3, 79-88; 153(1960). 24p. Dep. CFSTI.

13724 (UCRL-Trans-10432) REALISTIC STRESS CORROSION TEST. Brenner, P. Translated for Univ. of California, Lawrence Radiation Lab., Livermore, from Metall; 23: 879-86(1969). 18p. Dep. CFSTI.

13725 (USC-113-P-4-15) THE RATE OF OXIDATION OF Hg_2^{2+} BY $S_2O_8^{--}$ IN AQUEOUS SOLUTION. Raghaven, N. V.; Wilmarth, W. K. (University of Southern California, Los Angeles). [nd]. 23p. Dep. CFSTI.